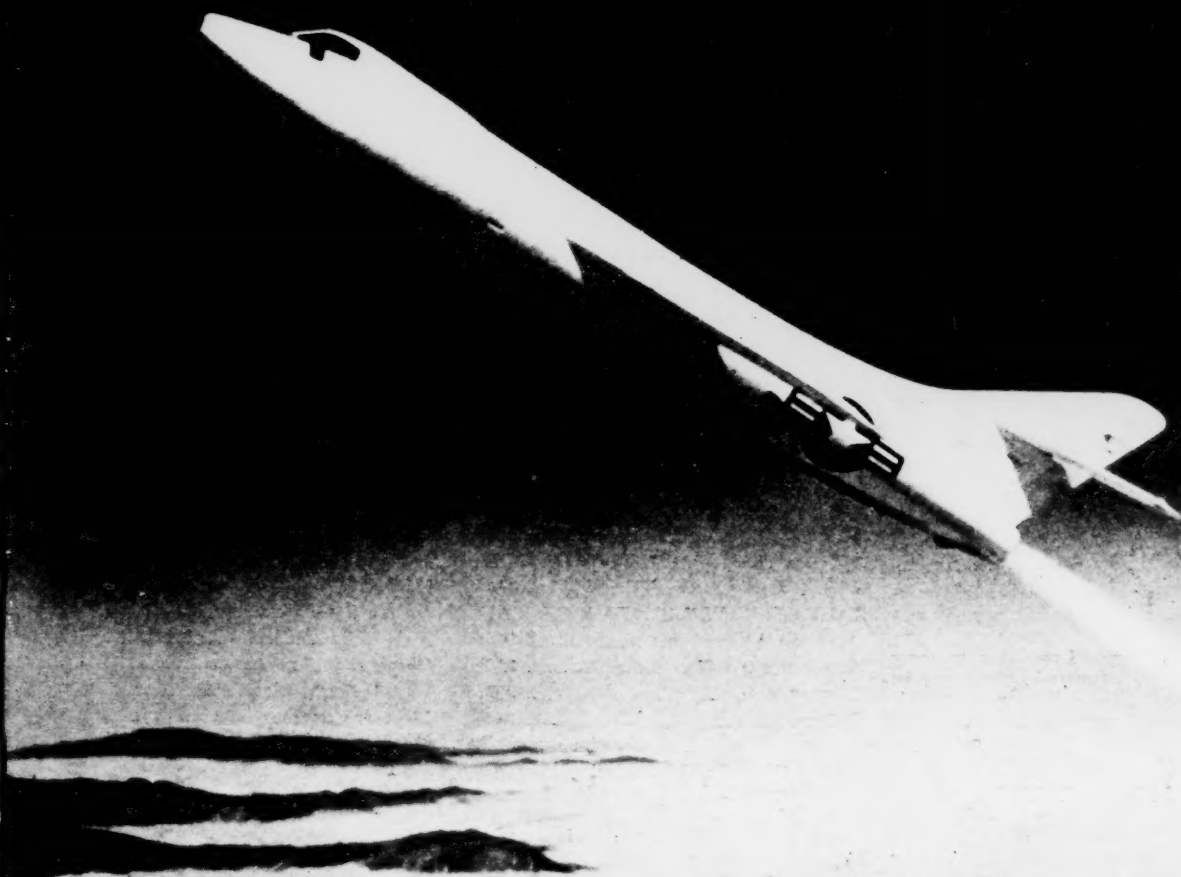


SPRING
1952
ASTRONOMICAL
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Sky and TELESCOPE



Skyrocket in flight

In This Issue:

★
Vol. XI, No. 12

OCTOBER, 1952

Whole Number 132

★

The Pardonable Errors
of Christopher Columbus

Four Possible Meteorite
Craters in Utah

The Advance of Rocket Science

The Sextuple System of Castor

Stars for October

Planetarium Astronomy and Navigation Courses

Six courses in astronomy and navigation, which will include use of the Zeiss planetarium projector, will be given in both fall and spring series at the Hayden Planetarium in New York City. The current classes begin in late September or October.

Modern Celestial Navigation, conducted by Capt. Clarence V. Lee, U.S.N. (Ret.), with half-hour celestial navigation exercise periods presented in conjunction with this course; **Applied Navigation**, also by Capt. Lee, which includes lectures and practical work with instruments and publications; **Astronomy Round Table for Beginners**, lectures combined with informal discussion and observing, by Henry M. Neely, planetarium lecturer; **Star Identification**, a practical observing course under the planetarium sky, given by Catharine E. Barry, associate curator of the planetarium; **Young People's Astronomy and Parents' Refresher Course**, given by Miss Barry in the planetarium chamber, and designed especially for children from eight to 14; **Descriptive Astronomy for Teachers**, 30 sessions with Miss Barry, using the planetarium, slides, and telescopes.

Further information about the opening dates, hours, and fees for the courses may be requested from the Hayden Planetarium, American Museum of Natural History, 81st St. and Central Park West, New York 24, N. Y. Each course but the last opens with an introductory session to which anyone interested is invited without cost or obligation.

STELLAR EVOLUTION FILM

A kinescope recording, with Dr. Otto Struve as guest scientist explaining stellar evolution, has been made available for public showing by the California Academy of Sciences. Dr. Struve, in the 30-minute television program, explains the continuous creation theory by means of a Kuiper model, diagrams, and slides.

The film, a recording of one of the academy's award-winning "Science in Action" television shows, is 16-mm. sound, and is complete with a 21-minute discussion of the subject and the program's "Animal of the Week" feature.

Bookings for the film for astronomy clubs and other interested groups may be made with Benjamin Draper, California Academy of Sciences, Golden Gate Park, San Francisco 18, Calif. The rental per showing is \$15.00.

PUBLIC NIGHTS AT GOETHE LINK

Two open nights will be held at Goethe Link Observatory in Brooklyn, Ind., in October, and two more in May, for which tickets may be had on request from the Astronomy Department, Indiana University, Bloomington, Ind. The October dates are the 5th and 12th, with lectures on "Eclipses," by Thomas J. Bartlett, and "The Magellanic Clouds," by Arthur N. Cox, respectively. The observatory will be open from 7 until 10 o'clock, standard time; the lecture will be given at 7:30 and again at 8:30. Telescope observing is scheduled for each evening.

Sky and TELESCOPE

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LETTERS

Sir:

The article, "Do We See a Lunar Tunnel?" by H. H. Nininger, in the June issue is very interesting. However, I do not think that his "Tunnel Ridge" is an elevation of any consequence. In the photograph accompanying the article, taken with the sun low in the west, the object certainly appears like a prominent ridge. However, in Lick Observatory photograph M4a, showing the appearance of this region with the sun very low in the east, what appears as the bright western slope of "Tunnel Ridge" in the first photograph still appears bright in the second!

It would seem that the bright western "slope" of "Tunnel Ridge" is, in reality, only a portion of a bright ray system emanating from the crater Tarantius.

ELMER J. REESE
241 S. Mt. Vernon Ave.
Uniontown, Pa.

Sir:

Dr. Nininger's lunar tunnel deduction is extremely ingenious, and seems almost undoubtedly correct. A thought concerning that double ray on the exit side: Possibly

the meteorite split on contact with the substratum and the two pieces formed two trails of lunite. It might be useful for visual observers with large instruments to search the rough ground to the east to see if the meteorite remains are visible; if it did split, two pieces approximately equidistant from Pickering should provide more confirmation than a single meteorite.

It would be well for someone to experiment with a wet plaster ridge in the laboratory, shooting (let's say) marbles through it at high velocity, to see if the total result would compare with the moon picture. Experiments of this sort have been made, of course, but probably not with a ridge.

EDWARD LINDEMANN
367 Whalley Ave.
New Haven, Conn.

Sir:

Nininger's theory is clever, but, it seems to me, the supposition is disproved by the fact that we see Messier and Pickering as circles, not ellipses. A U-shaped tunnel would be needed.

L. S. COPELAND
626 E. Valerio St.
Santa Barbara, Calif.

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WHOLE NUMBER 132

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BACK COVER: The spiral galaxy NGC 4736, Messier 94, in Canes Venatici, photographed with the 200-inch Hale telescope. A 60-inch Mount Wilson picture of the same object, oriented at 90 degrees to this, appeared on the back cover of the September, 1950, issue, where further information concerning the galaxy was given on page 266. Mount Wilson and Palomar Observatories photograph.

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The Pardonable Errors of Christopher Columbus

By E. RUSSELL PATERSON

Sir George Williams College, Montreal

IT IS NOT to the discredit of Christopher Columbus to state that his discovery of the New World was the lucky outcome of miscalculations founded on scientific errors. The greatness of Columbus rests on his dogged acting on his convictions, his courage, and his powers of leadership. The basis of his convictions was the faulty science of the 15th century, for which he was in no way responsible, and which was the cause of his miscalculations.

The theory of the spherical shape of the earth appears very early in the story of science. It was taught by the Pythagoreans in the 6th century B.C. This development from the earlier belief that the earth is a flat plane (as it appears to be to a restricted view) probably arose from three considerations. The curved nature of the ocean surface was indicated by the common observation of the gradual disappearance of an outbound ship, hull down over the horizon. Travelers journeying north or south noticed new constellations appearing over the northern or southern horizons respectively—a situation impossible if the surface of the earth were flat.

To the early philosopher-scientists the sphere was the perfect solid form, and if the earth were curved at all, it must in their opinion be spherical. This shape was confirmed by the third observation. By 300 B.C. it was recognized that a lunar eclipse was due to the moon encountering the earth's shadow, and observers noted that the edge of the shadow was always an arc of a circle no matter what part of the earth was projected to form the edge. Columbus

A woodcut of Columbus, published by André Thévet in Paris in 1584. It is reputed to have been obtained by Thévet in Lisbon, and to have been done by a Dutch artist while Columbus was living there. It is a likeness said to agree fully with descriptions of Columbus' appearance. The five background stars are thought by some to represent the Southern Cross, by others to be Ursa Major.



inherited the belief in a spherical earth. This belief was, however, confined to scientifically minded thinkers, and it is probable that his sailors did not share it. The theory was not generally accepted until explorers had succeeded in circumnavigating the earth in the following century.

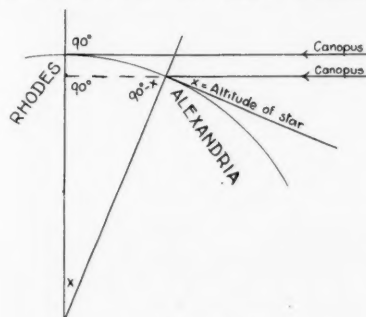
The size of the spherical earth was the next factor in Columbus' calculations. The best modern measurement gives a circumference of 24,900 miles. The great Aristotle, whose dicta in most sciences were held infallible in Columbus' time, while he made no estimate himself, reported conclusions of "the mathematicians" that the circumference was 45,000 miles. The earliest truly scientific attack on the problem of which we have a record was the work of Eratosthenes of Alexandria in the 3rd century B.C. He noted (or heard the report) that at noon at the summer solstice the sun shone directly down deep

wells at Syene in Egypt (modern Aswan), 500 miles south of Alexandria. Working at Alexandria he measured the angle of the shadow cast by a gnomon at noon at the summer solstice. Simple geometry (as illustrated in the diagram) showed that this was also the angle at the center of the earth subtended by the arc between Syene and Alexandria. As he read it as $1/50$ of a circle, he concluded that the circumference of the earth must be 50×500 miles, or 25,000 miles. While his method is perfectly correct in principle, the details of his calculations were erroneous (Syene is not exactly south of Alexandria and is half a degree north of the Tropic of Cancer), and the amazingly accurate result is due to Eratosthenes' good fortune in that his errors pretty well canceled out.

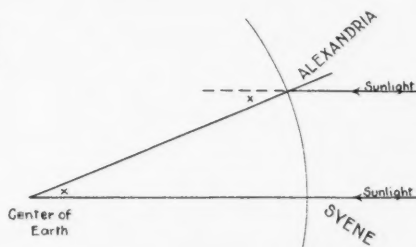
The estimates of circumference of the earth made by Eratosthenes and later Greeks were expressed in stadia. The stadion was the standard length of the athletic field in Greek games. Unfortunately, the standard varied in different parts of the Greek world, and it is never clear what stadion was referred to by an author. The variation was between 172 yards and 202 yards. For the sake of clarity, this article translates the stadion as $1/10$ mile.

Eratosthenes' estimate of the earth's circumference was 250,000 stadia. The Greek mind always liked to keep things tidy, so he cheerfully added 2,000 stadia so that his total (252,000) would be simply divisible by 360 degrees.

About 100 B.C., Posidonius of Rhodes attacked the problem using the maximum altitudes of the star Canopus as



POSIDONIUS



ERATOSTHENES

The principles of two methods of measuring the size of the earth in ancient times, one by the altitude of Canopus above the southern horizon, the other by the noontime altitude of the sun at the summer solstice.

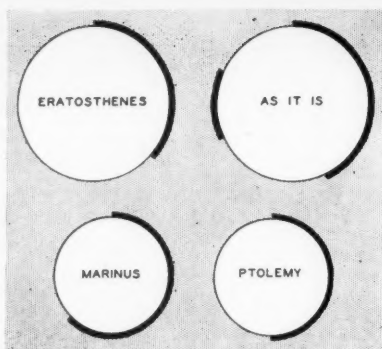
seen from Rhodes, where it appears just over the horizon, and from Alexandria (see the diagram). From this he deduced that the angle at the center of the earth formed by radii to these two places was $1/48$ of a circle. The distance between them he accepted as 375 miles, using the rough guesses of mariners sailing from one port to the other. This gave a circumference of only 18,000 miles—a much smaller earth than that calculated by Eratosthenes. Marinus of Tyre, writing about A.D. 100, accepted this estimate of size made by Posidonius, and Marinus is an important figure in the story later on. The smaller earth was also taught by Ptolemy of Alexandria, about A.D. 150. Ptolemy is best known for his astronomical treatise, the *Almagest*, but his *Geographica* was the most influential classical treatment of that subject, even superseding Aristotle, and was readily available in translation throughout Europe in Columbus' time.

The third factor in Columbus' calculations concerned the extent of the land mass. To the Greeks (and this belief persisted through the Middle Ages) there was only one land mass—an irregular but rather narrow strip running east and west from Spain to the Orient, bounded by the all-surrounding ocean. It was considered longest at about north latitude 36° , the zone of Rhodes and southern Spain. The latter was obviously the western limit. How far the land extended to the east, however, was largely a matter of conjecture. Successive explorations pushed the eastern limit farther and farther around the curved earth as new lands were discovered. We must remember the extremely crude methods of calculating distances overland, mainly in number of days' journeys, and if the routes were tortuous the resulting totals were fantastic.

The geographical terms latitude and longitude arose from the concept of the shape of the oblong land mass. Measurements north and south were across its width (latitude). Longitude (length) referred to east-west measurements.

The length of the land mass, and the size of the earth around which it was wrapped, determined all estimates of the extent of the gap between Spain and the Orient. Columbus was not the first by any means to consider sailing westward to the Orient; the possibility of doing so was discussed by Strabo, the famous geographer of the 1st century B.C., but he believed it could not be done. The problem was that of supplies, for if an unbroken ocean stretched between the two ends of the land mass, ships would have to carry sufficient food and water for the whole trip.

At the time of Eratosthenes, India was known through the conquests of Alexander the Great, and the scientist estimated that the land mass stretched around 130° of his larger earth, leaving



"THE LAND MASS"—At N. Lat. 36°

an unbroken ocean of 230° width. Posidonius apparently made no estimate, but Marinus took into account new lands discovered east of India and calculated that 225° of his smaller earth was covered by the land mass, leaving an ocean of 135° . Ptolemy, whose views were accepted most widely in the Middle Ages, gave a 50-50 estimate—an ocean of 180° and a land mass of similar extent.

It is known that Columbus' principal source of geographical ideas was a book entitled *Imago Mundi*, written about 1400 by Cardinal Pierre D'Ailly; Columbus carried a copy with him on his voyage and made marginal notes as he proceeded. This book incorporated the views of Marinus with his ocean of 135° . By this time, however, lands still farther east had been visited by explorers, including Marco Polo, and Columbus revised the figures to a land mass of 240° and an ocean of only 120° .

The final problem was the translation of measurement in degrees to actual mileage. It was known that at 36° north a degree of longitude expressed in miles represents four fifths of the mileage of a degree at the equator. D'Ailly reported that Moslem mathematicians had calculated the latter as $56\frac{2}{3}$ miles, but this unit was the Arabian mile. Columbus seemingly misinterpreted it as the Italian nautical mile which he was accustomed to use. The consequence was that he greatly underestimated the actual mileage across his assumed 120° ocean. It was this miscalculation which gave him confidence that a flotilla of ships could carry sufficient supplies to make the passage.

Then came the famous controversy between Columbus and those who opposed his venture. The former argued in favor of the views of Marinus as expounded by D'Ailly, but with the figures revised on the basis of the new discoveries. The opponents represented the conservative scientific attitude of the time, with Ptolemy as the authority and his ocean stretching halfway around the earth. Both of course were wrong, but, excluding the unknown Americas, the opponents had the better science.

When Columbus received the authorization he sought, he set sail and after two months reached "San Salvador," usually identified as Watling Island in the Bahamas. Methods available at that time of keeping track of distances sailed east and west were very crude; as there was no scientific method of calculating longitude, and Columbus reported that he had sailed not merely 120° (his own forecast), but 135° west from Spain, thus vindicating Marinus. The truth was that he had proceeded 65° . Undoubtedly the expedition would have been disastrous if his theories had been correct. His good luck was that he encountered the New World en route.

Author's Note: Fuller details concerning the theories of Columbus can be found in *The Story of Human Error*, edited by Joseph Jastrow (D. Appleton-Century Co., 1936). The geographical section of the book, on which this article is mainly based, was written by Prof. John Barger Leighly, of the University of California.

VELOCITY OF LIGHT

The velocity of light is a fundamental constant whose importance grows with the ever-increasing potential accuracy of optical and electronic measuring equipment. Hence each new determination is carefully weighed by astronomers and physicists. Erik Bergstrand in Sweden has made several determinations of high accuracy, and in a recent issue of the *Arkiv för Fysik* of the Swedish Academy of Sciences he presents the details of "a check determination."

His investigation was carried out with a base line of six kilometers on the island of Oland. His 1950 check results are here listed with his previous results:

Date	Velocity (km./sec.)
May 1949	$299,793.04 \pm 0.19$
Sept. 1949	$299,793.10 \pm 0.20$
Aug. 1950	$299,793.14 \pm 0.42$

The weighted mean of these measurements he gives as $299,793.1 \pm 0.2$ kilometers per second.

SPECTROSCOPIC BINARY ORBITS

In 1948, J. H. Moore and F. Neubauer at Lick Observatory published the fifth catalogue of spectroscopic binaries. This comprised a list of 480 stars for which orbital elements had been determined. A supplementary list has now been published by Roger Bouigue in the *Annals of the Observatory of Toulouse* (Vol. 21). The French supplement contains 111 stars, of which about half are new. For the others, revised orbital determinations have become available since 1948.

THE ADVANCE OF ROCKET SCIENCE

By FREDERICK I. ORDWAY

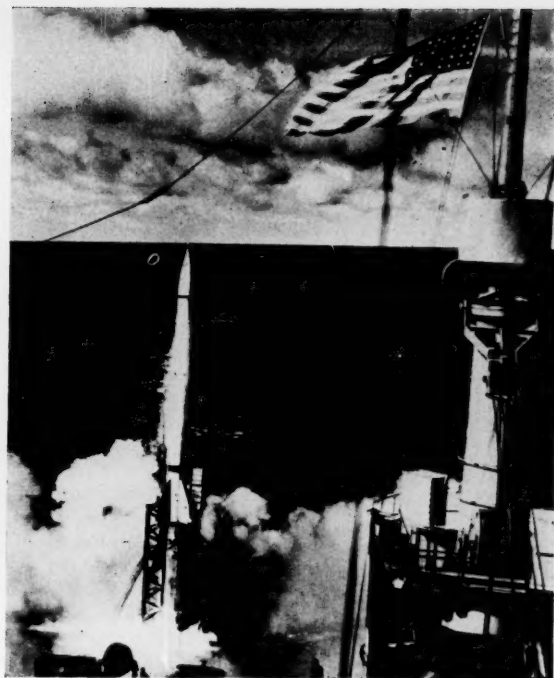
Engineering Division, Reaction Motors, Inc.

RECENT YEARS have witnessed an enormous growth of interest both in rockets and in the rising science of astronautics. This is evidenced by the great volume of books and articles, meetings, symposiums, and conventions in these fields on technical and semitechnical levels. More and more people, businesses, government agencies, and scientific societies are showing keen interest in such things as mass ratio, satellite vehicles, space rockets, interplanetary flight, and space medicine. Ten years ago these subjects were either laughed at or not even known.

The formation of the International Astronautical Federation (*Sky and Telescope*, February, 1952, page 83) signaled graphically the improvement in the climate of scientific opinion toward space travel and astronautics. At the London congress a year ago, representatives of 11 nations talked on such topics as "Biological Problems of the Satellite Vehicle," "Landing of Space Craft," and "Orbital Rendezvous Problems." The Third Astronautical Congress has been held this September, at Stuttgart, Germany.

In the United States there are at least five rocket societies. The oldest and by far the largest is the American Rocket Society, organized in 1930 as the American Interplanetary Society.

A Navy-Martin Viking rocket begins its journey toward a height of 105 miles from the deck of the U.S.S. "Norton Sound." This is an American-made missile that has exceeded the altitude records formerly held by V-2 rockets. U. S. Navy photograph.



In 1934, however, its name was changed, undoubtedly because the word "interplanetary" was considered by the public to be synonymous with "madness," at best. For a good scientist to be associated with such a group was unusual, and in no way aided his reputation. Hermann Oberth in Germany could easily write his monumental *Wege zur Raumschiffahrt* (Way to Space Travel), whereas in this country our famous Robert H. Goddard had to be content to title his work, *A Method of Reaching Extreme Altitudes*.

Fortunately, we have come a long way since. The advent of atomic energy (also "impossible" 20 years ago)

and the phenomenal German rocket developments have had far-reaching effects. Societies that deal with rockets can now often touch on interplanetary or space flight without embarrassment. Serious books are finding their places in many libraries: *Space Medicine*, 200 Miles Up, *Interplanetary Flight*, *Exploration of Space*, and *Rockets, Missiles, and Space Travel*.

There are some half dozen companies occupied either wholly or partly in rocket research and development. Aerojet Engineering Corp., Azusa, Calif., and Reaction Motors, Inc., Rockaway, N. J., are the only two engaged 100 per cent in rocket research, but others, such as General Electric and M. W. Kellogg, are devoting part of their facilities to the problem. Numerous universities, small research groups, and government agencies are active in the rocket and guided missile fields.

As a result of this activity, rockets themselves are beginning to make the news. The Viking rocket was developed in America. Pictured here being launched from the U.S.S. *Norton Sound* is Viking No. 4, fired in 1950, which reached an altitude of about 105 miles. This high-altitude research vehicle, Reaction Motors powered, develops over 20,000 pounds thrust at sea level, is about 45 feet long, 32 inches in diameter, with a gross weight of about five tons. (A redesigned Viking is somewhat shorter, fatter and heavier, having greater fuel capacity). The No. 7 Viking holds the world's single-stage rocket altitude record of 135 miles. The power plant usually fires for about 75 seconds, during which time the missile may reach 30 or more miles in altitude,



Shown here ready for flight on its launching ramp is a booster rocket designed to use solid instead of liquid fuels. It develops a sea-level thrust greater than the 56,000-pound thrust of the German V-2, and is believed to be one of the largest solid-propellant missiles flown. It must be boosted to nearly supersonic speed to operate well. It is without a name, but some call it the "flying stovepipe." U. S. Navy photograph.



From a mother ship, a B-29, the Douglas 558-2 Skyrocket plane is released in the favorable operating conditions of high altitudes, from which the Skyrocket can climb faster to even greater heights. U. S. Navy photograph.

its velocity passing 4,000 miles per hour. Most Vikings are launched from White Sands Proving Ground.

The Skyrocket airplane, pictured on the front cover, and shown here being launched from a mother B-29, was designed to attain high-altitude sonic level flight speeds. It has instrumentation capable of obtaining performance, stability, control, and airload data. To increase swept-wing flight knowledge, a 35-degree wing sweep was incorporated in its design. The first rocket-powered flight was early in 1949, and by September, 1950, the first air launch of a combination jet and rocket-powered Skyrocket was made. In one supersonic flight, the world's speed record was broken; in another, the manned altitude record. The Skyrocket is reported to have flown at 1,238 miles per hour; its top reported altitude is 79,494 feet, exceeding the old record of 72,395 feet set in 1935 by stratosphere balloon.

Unfortunately, much of the work dealing with rockets is classified and is unavailable to most people. But we all may speculate that some extremely interesting developments should be forthcoming. Pratt and Whitney and General Electric have been awarded government contracts for work on research leading to a practical atomic engine for aircraft, so we may suppose that such work will sooner or later begin for atomic-powered rockets.

The famous satellite vehicle project has received much attention in American magazines and newspapers, and in books. Such a vehicle would be made to revolve around the earth as an artificial moon, and would carry both sci-

entific and military observers. Fantastic as it sounds, it is considered to be within present-day engineering ability, given sufficient time and money (*Collier's* magazine, March 22, 1952).

Space medicine is a subject taken very seriously by the U. S. Air Force, with the result that the Institute of Space Medicine has been set up as part of the Air Force School of Aviation Medicine at Randolph Field, Tex. At a symposium last November in San Antonio, space medicine officials pointed out that severe obstacles are to be expected as man pushes into the upper atmosphere and the threshold of space. The biologic and genetic effects of radiation on human beings were discussed, and whether or not the life span of the crew man of some future moon rocket might be shortened by ionization and radiation damage to his body. The Nobel-prize-winning geneticist, Dr. H. J. Muller, added an optimistic note that ways will be found to shield the future spaceship effectively.

At last November's convention of the American Rocket Society and the American Society of Mechanical Engineers in Atlantic City, N. J., Navy Comdr. R. C. Truax received an award for his experimental work on rockets. He stated that rocket development should have as its goal the achievement of interplanetary travel. A. S. Alexander, undersecretary of the Army, speaking at the honors night dinner, noted the importance of continued intensive work on rockets for our national defense.

Recent American Rocket Society meetings have featured such speakers as Dr. Marcel Golay, of the Army Signal

Corps Engineering Laboratory, who talked on "Radio Ranging in Outer Space." Not only did he present very useful data on some of our planetary neighbors, but he approached the problem of interplanetary navigation, using some possible routes to Mars and Venus as examples. The possibilities of radio control or guidance of both manned and unmanned space rockets provided the substance of the lecture. It appears that if 1,000 watts of power were radioed to a spaceship 100 million miles distant, its receiver would pick up only 10^{-18} watts. This is quite a difference, but at least it seems theoretically possible to do some long-range radio signaling.

In presenting a paper, "Unusual Applications of the Momentum Principle," T. F. Reinhardt, of the Naval Air Rocket Test Station, astounded his audience by reviewing, as rocket propellants, beams of light and streams of electrons. He looked into these possibilities in an effort to get away from the distinct limitations that liquid chemical fuels impose on rockets. The beam of light idea showed that an incredibly high specific impulse (an expression denoting the pounds of thrust obtained per pound of propellant burned per second) would result, but that the power required to produce even one pound of thrust would be well over a million kilowatts. The electron-stream rocket looked better, but it suffered the same limitation.

Though it was admitted that chemical fuels would be around for a long time to come, the big hope seems to lie in atomic power. Eventually rockets will probably be propelled by some atomic reactor scheme with a high power-to-weight ratio.

An ad hoc committee on space flight has been formed by the American Rocket Society. One of the major tasks of this committee will be to create a favorable "unsensational" public attitude toward the space flight theme. This presumably could be accomplished by press releases, cautious advertising of the idea, by speeches and symposia open to the public.

At the combined American Rocket Society-Institute of Aeronautical Sciences convention recently, Dr. P. F. Winternitz, of Reaction Motors, Inc., remarked that the time is approaching when "the inhabitable space (on the earth) becomes a pressing problem." Sooner or later, the pioneers of tomorrow will have to explore beyond the confines of our home planet. Dr. Winternitz believes that "the enormous problems of interplanetary flight can be solved only by the co-operation of all nations," and he adds, "These problems will also create considerable danger." Be that as it may, he thinks that the conquest of space will prelude a "new and brilliant future of mankind."

NEWS NOTES

BY DORRIT HOFFLEIT

PAUL W. MERRILL RETIRES

It is hard to believe that Paul W. Merrill should already be retiring from the Mount Wilson and Palomar Observatories, after a 33-year astronomical career in Pasadena. His alertness and flow of publications within recent years lead us to expect many more contributions from his pen. His book, *The Spectra of the Long-Period Variables*, is a gold mine of information in that field. Another, *The Story of Variable Stars*, has served both the amateur and professional. And his catalogues of B-type stars showing emission features will be a research guide for years to come; for these are to be studied for the peculiarities of shells or envelopes surrounding the hotter stars.

Dr. Merrill has been the editor of Mount Wilson Observatory publications since 1939. He is a member of the American Philosophical Society and the National Academy of Sciences, whose Henry Draper medal was conferred upon him in 1946. Then he also received the Bruce medal of the Astronomical Society of the Pacific.

TEMPERATURE 0.0015° KELVIN

Absolute zero, we used to learn, is unattainable. But physicists keep getting closer and closer. The latest record, according to Science Service, is unofficially held by Dr. Dirk DeKlerk at the National Bureau of Standards, who used a Collins helium cryostat to produce a temperature of only 15/10,000 of a degree above zero on the Kelvin scale.

The process is called adiabatic demagnetization. By means of the cryostat, which condenses and cools helium to within one or two degrees of absolute zero, a paramagnetic salt was made equally cold. Then it was placed in the field of a powerful electromagnet, which "established order in the molecules of the substance," according to Dr. DeKlerk. The excess heat was carried away by the helium refrigerating system and the record low temperature was reached.

UNUSUAL FLARE STAR

U Pegasi is an eclipsing binary of the W Ursae Majoris type. In such stars, the components are dwarfs that are very close together. The period of revolution of U Pegasi is a little over a third of a day.

Masaaki Huruata and his associates at the Tokyo Observatory have been observing this star photoelectrically in three colors (effective wave lengths 3959, 4650, and 5550 angstroms). Only in the shortest of these does the star show

prominent flares amounting to about 3/10 of a magnitude near the times of maximum light.

In the *Publications* of the Astronomical Society of the Pacific, Huruata suggests that the flaring phenomenon may be confined to the space between the components and therefore be an effect of their tidal bulges. But other stars of this type he has been observing do not show such flares. U Pegasi is notable also for a higher eccentricity of its orbit than usual, and this may be related to the flare phenomenon. Another association with flares at short wave lengths may be the great strengths of the emission lines of ionized calcium (H and K lines) in the violet region of the spectra of stars of this type.

CEPHEID COLOR PHASES

In their work on six-color photometry of the variable star Delta Cephei, Stebbins and Whitford about 10 years ago found that maximum light did not occur in all colors at the same time. A similar situation was later noted for another typical Cepheid, Eta Aquilae. Dr. Stebbins interpreted this as follows:

When the radial velocities indicate that the star is expanding, the increase in the size of its disk is more than counterbalanced by a decreasing light intensity for short wave lengths, and the star begins to fade. For the longer wave lengths, to the contrary, the in-

IN THE CURRENT JOURNALS

RADIO-ASTRONOMY, by M. Ryle and J. A. Ratcliffe, *Endeavour*, July, 1952. "... the study of those radiations which reach the Earth from outer space and are transmitted through the radio-frequency window to the surface of the Earth."

VARIABLE STARS AND GALACTIC STRUCTURE, by Cecilia Payne-Gaposchkin, *Nature*, August 9, 1952. "Although only a fraction of the total of galactic variable stars has been discovered, their apparent distribution, in conjunction with our knowledge of their luminosities, and approximate corrections for obscuration, permits us to draw certain conclusions about true distribution."

THE ATMOSPHERIC ECLIPSES OF FOUR SUPERGIANT BINARY SYSTEMS, by Dean B. McLaughlin, *Publications*, Astronomical Society of the Pacific, August, 1952. "The Michigan Observatory now has good series of spectrograms during the atmospheric eclipses of the four supergiant systems: δ Aurigae, 31 Cygni, 32 Cygni, and VV Cephei. . . . The present paper attempts a qualitative comparison of the eclipse phenomena and of the structure of the atmospheres of the late-type components of these four systems."

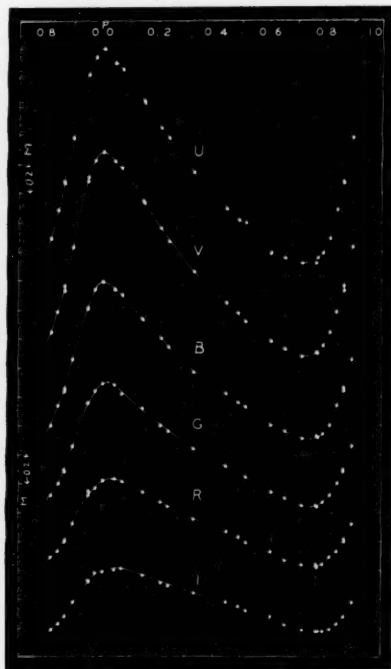
crease in size is more important than the decrease in surface intensity and for these colors the star continues to increase in brightness. This theory was proposed only qualitatively.

Now Takeshi Dambara, Tokyo Astrophysical Observatory, has developed the theory mathematically and finds remarkably close agreement between the predicted and observed time lags of maximum or minimum light for the six colors. Moreover, Dambara points out that the lag should be greater the longer the period of the Cepheid variation.

WHITE MOUNTAIN RESEARCH STATION

In the Inyo National Forest on the California-Nevada border, a year-round high-altitude research station has been operated by the University of California since 1950. Now it is announced that this White Mountain Research Station on Mt. Barcroft is being supported by the National Science Foundation, the Office of Naval Research, and the Rockefeller Foundation, these agencies having guaranteed support of \$36,000 per year for three years.

Under the direction of Professors Nello Pace and S. F. Cook, University of California, facilities for biological, medical, and physical science studies are available at sites at 10,500 feet and 12,500 feet, while limited experimentation can be carried on at 14,256 feet, on the summit of White Mountain itself.



The Stebbins-Whitford light curves of Delta Cephei, in six colors from ultraviolet to infrared. Note the lag of phase with increasing wave length.



Two views of the crater region, the left one from the west, the right one taken from the south and toward the direction from which the presumed meteorites may have come. The men are each standing in a crater. All field photographs by E. N. Parker.

Four Possible Meteorite Craters in Utah

BY RICHARD N. THOMAS, *University of Utah and Harvard Observatory*

IN SOUTH-CENTRAL UTAH, on Highway 22 midway between the towns of Kingston and Antimony, Raymond S. and Gail Whittaker, two Circleville stockmen, have some grazing land near which their work takes them every one or two days. Here lies a rock wash in the form of an elevated outcropping in the middle of a region covered by sagebrush.

Several days after the sunshine meteor of July 7th was observed in the Northwest (see page 312), the Whittakers noted small depressions on this rock wash that had not been there several days previously. Raymond Whittaker wrote to the astronomy department at the University of Utah:

"A large area of ground on a gentle foothill near pasture property of mine has been seared of all brush and ground covering very recently. There are also three depressions in the earth in this area. The brush that hasn't been ripped up has been knocked flat to the ground and stripped of all leaves. Then, too, much of the brush is charred with a black covering as if it had been in contact with an intense heat. There has been a definite explosion with much force in this area. The possibility of fragments from the meteor occurred to me, and that is why I am writing to your department."

We visited this spot on July 23rd, when the accompanying pictures were made by Dr. E. N. Parker, of the Uni-

versity of Utah staff. C. B. Crane, science teacher at Piute County High School, accompanied us to the scene, interpreting the topography from the geological point of view.

Four craters in all were found, each about four feet in diameter and between six inches and one foot deep. They are indicated in two of the pictures by persons standing in them. Three are in a line, uniformly spaced at approximately 15-foot intervals, on a shelf beneath a small cliff or bank. The fourth crater is higher, to the north of the middle crater of the three. The cliff was present before the craters appeared, according to the Whittakers.

Under the assumption that the craters were caused by a meteorite fall, we attempted to find some indication of the direction of fall. Associated with each of the three lower craters was found a small semicircular indentation in the edge of the bank, and there were no other such indentations elsewhere along the edge. The upper crater has no ledge associated with it, nor could we find on the hillside surrounding the crater any evidence of other indentations.

By sighting downward past each indentation toward the crater below it, we could ascertain that an object causing each crater would have come from due north at an angle of fall between 30 and 40 degrees with the horizontal. It was also possible to check this estimate by sitting in a crater and sighting upward and northward past the corresponding indentation in the ledge above.

No persons had witnessed a fall of a meteorite in the vicinity, and a reasonably careful search failed to produce any trace of a rock type that could not be found at other spots within several miles of this rock wash. Nevertheless, the



A view of the scene from the northeast, toward the main highway. In the lower right is some of the torn and seared sagebrush.



A portion of the ledge is shown here, somewhat out of focus close to the camera. One of the indentations may be seen, centered in the field, and beyond it one of the craters in the area below the ledge.



This view of the sagebrush along the edge of the rock wash shows how it was torn and burned, whereas the brush growing farther away, in the upper right of the picture, was not disturbed.

opinion of the members of the search party was strong that we had indeed found traces of a recent meteorite fall.

First, there is the geometry of the craters already described.

Second, with a flight of four particles, there would be associated an extensive series system of four shock waves which would combine to give a high-pressure, high-temperature region extending some 10 to 15 feet on each side of the outer particles. The enveloping action of the principal shock wave is shown by the accompanying illustration of paraffin particles in high-speed flight.

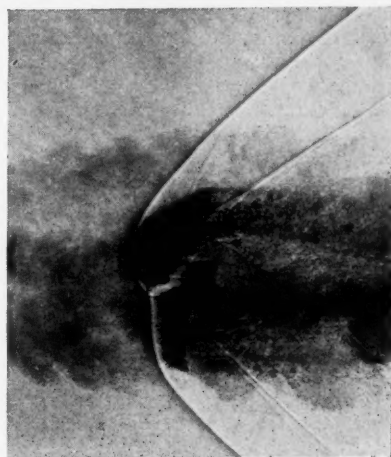
The dead sagebrush was charred and burned, while the green sagebrush was simply torn and shredded. On the rock wash itself, we were told by the Whitakers, very little sagebrush was growing prior to their observation of the craters. The distance apart of the craters indicates that the particles themselves would have occupied a diameter of about 30 feet; the associated high-pressure, high-temperature region in the gas would cover a diameter of some 50 to 60 feet. Reconstructing the orientation of the shock-wave system from the position of the meteorite craters, we found the seared and torn region among the sagebrush to be in excellent agreement.

The third indication is the shape of the craters themselves, which all had their steep sides lying toward the north. In the past it was believed that such

an unsymmetrical crater would be produced by a meteor coming in from the shallow side. But recent experimental work on the firing of ultraspeed pellets into plaster of Paris and other materials by J. S. Rinehart, W. C. White, and their collaborators at the Naval Ordnance Test Station, Inyokern, has demonstrated that the direction of fall is actually from the deep side of the crater toward the shallow side. These Utah craters may thus be an actual example of Rinehart's principle (see *American Journal of Physics*, 20, No. 1, 1952).

Fourth, there is the relation between crater diameter and depth. The relative dimensions are in good agreement with the diagrams given in Ralph Baldwin's book, *The Face of the Moon*, for the proportions of craters formed by meteors and by explosives.

One of these criteria by itself might not be sufficient to establish the craters to be meteoritic, but taken together they give a reasonable expectation that these four craters were indeed produced by meteors. The association with the daylight meteor of July 7th may be only fortuitous, particularly since that meteor appears to have traveled from south to



A common shock wave envelops a close group of high-speed particles, in this case paraffin. Photograph courtesy Ballistic Research Laboratories, Aberdeen Proving Ground.

north over a ground path hundreds of miles from Circleville.

The author and Dr. Parker acknowledge with thanks the aid of the Naval Ordnance Test Station in pursuing the investigation here reported.

ASTRONOMER

*He makes the Universe his home,
And in his magic mirror scans his vast
domain;
Far from the ties of earth he loves to
roam
On wings of light the cosmic chain.
Eagerly each phenomenon he records —
An asteroid or comet passing near,
A super star among the countless hordes
That dot his ever-widening frontier.
Out and beyond where all time lies,
With camera he probes a billion years
of space,
And through the medium of light, be-
fore his eyes
The present and a billion years ago
come face to face!*

JOSEPH KNAPP

A closeup of one of the craters, showing the rough character of the ground. A search of the area for meteoritic fragments was fruitless.



The Sextuple System of Castor

BY OTTO STRUVE, *Leuschner Observatory, University of California*

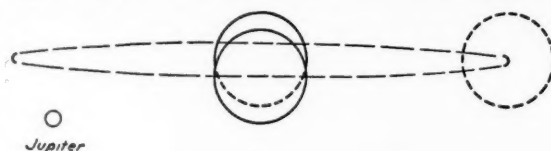
EVER SINCE Bradley and Pound, in 1719, discovered that Castor is a visual double, this bright star of our winter and spring skies has attracted the attention of double star observers. Castor is not only double—it is a visual triple star. In addition to the two blue, 2nd-magnitude stars, whose separation is now three seconds of arc, there is a faint red companion at a distance of about 72 seconds that shares the proper motion of the brilliant pair and is thus a physical member of the group.

The bright blue stars are known as Castor A, or α_2 Geminorum, and Castor B, or α_1 Geminorum; the distant companion is Castor C, and its visual magnitude is 9.7.

In 1896, Belopolsky at Poulkovo found that the fainter of the two blue stars (Castor B) is a spectroscopic binary with a period of 2.9 days, while Curtis discovered in 1904 at Lick Observatory that the bright blue star is also a spectroscopic binary. Its period is 9.2 days. (See the table on page 303.) The period of these blue binaries around each other is 380 years, according to K. Aa. Strand, who in 1940 determined their orbit with the help of a long series of accurate photographic observations.

The faint red companion is also a spectroscopic binary, according to the work of A. H. Joy and R. F. Sanford, who determined the period of this close pair of stars as 0.81 day. The orbital plane is almost exactly in the line of sight; consequently, there are two eclipses in every cycle of 19½ hours. Castor C is thus an eclipsing binary and

A diagram of the system of YY Geminorum, by G. E. Kron, of Lick Observatory. Reproduced from the "Astrophysical Journal."



is known to photometric observers as YY Geminorum. The spectrum of each of its components is visible, and we infer from this fact that the two stars are very nearly equal in brightness, and presumably also in color, size, and mass.

We have thus a system of six stars, and to a student of the origin and evolution of multiple stars it presents a challenge of the utmost interest.

CASTOR C

To determine the masses of the components of Castor C, we make use of Kepler's third law, as derived from

Newton's law of universal gravitation. Elementary textbooks describe the derivation of the equation,

$$m_1 + m_2 = R^3/P^2,$$

which states that the combined mass of two mutually attracting bodies, expressed in terms of the sun's mass, equals the ratio of the orbital radius cubed and

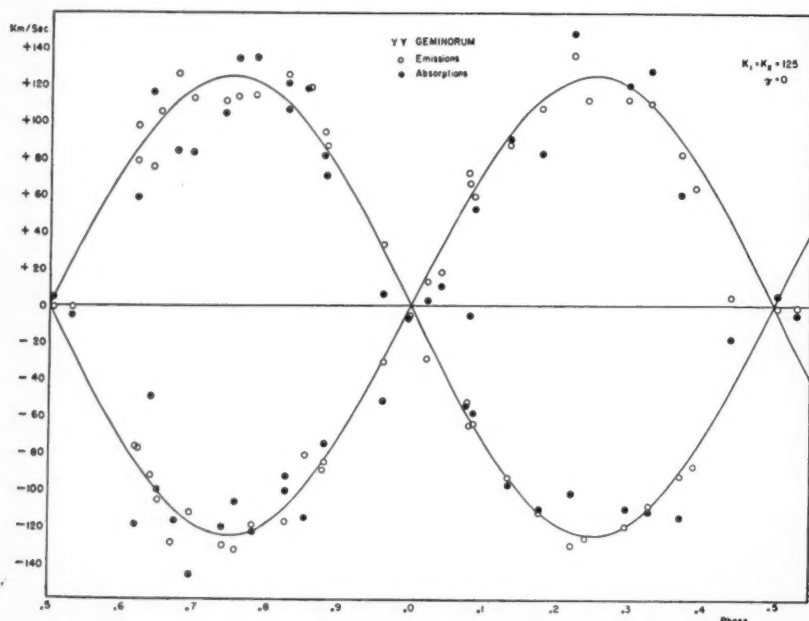
the period squared. The radius must be expressed in astronomical units (earth-sun distance, or 1.5×10^8 kilometers). The period must be given in years. It is especially important to remember that the orbital radius is referred to the heavier of the two bodies as the origin. In a circular orbit, we take the distance between the two bodies, not the distance of the companion from the center of gravity.

What, then, is the radius of the orbit of YY Geminorum? From the periodic oscillation of the Doppler shift of each set of spectral lines, we find that the approximately circular orbital velocity of each component is about 125 kilometers per second with respect to the center of gravity of the system, or 250 kilometers per second for one component with respect to the other. The period of 0.81 day is about 70,000 seconds. The circumference of the entire orbit is thus $250 \times 70,000$, or 175×10^5 kilometers. The orbital radius is about 6.28 times smaller, 28×10^5 kilometers, or 2/100 of an astronomical unit.

The period is equivalent to about 2/1,000 of a year. Hence, the total mass of YY Geminorum is $(2/100)^3 / (2/1,000)^2$, or two solar masses. More accurate computation yields somewhat smaller figures, of the order of 0.7 times the mass of the sun for each component.

A diagram of Castor C by G. E. Kron has been published in the March, 1952, issue of the *Astrophysical Journal*, and is reproduced above. This is the most interesting member of the Castor system, and Kron's recent work at Lick Observatory has shown that at least one of the red components is subject to violent spot formation. He has even succeeded in delineating (not uniquely, however) the location and relative sizes of a few conspicuous dark and bright spots on one of these stars.

These spots seem to appear and disappear at irregular intervals. Because



Velocity curves of Castor C (YY Gem), from McDonald Observatory spectrograms by G. Herbig, H. Horak, and the author. Where the two curves cross, one star is eclipsing the other, and their relative motion along the line of sight is zero. Their maximum velocities of recession and approach occur when they are at the "ends" of the orbit; for instance, one would be in the position of the dashed circle at the right in Dr. Kron's diagram above. This diagram was published in 1950, in the "Astrophysical Journal."

of the axial rotation of the star, in the same $19\frac{1}{2}$ -hour period of the orbital revolution, the spots continuously change their apparent positions on the star's disk and thus influence the photoelectric light curve. Moreover, the eclipses cause sudden disappearances and reappearances of the spots which can also be distinguished in the light curve. The periodicity of the spots is identical with the rotation of the star. But, since new spots may appear at different places on the surface of the star, the distortions of the light curve show sudden changes in phase, even though the periodicity is absolutely exact while any given spot or group of spots is active.

CASTOR A AND B

For the bright stars of the Castor system, the information from the Doppler effect is more fragmentary than in the case of Castor C. In each case, we observe only the spectral lines of the brighter component of the pair, and we thus find the orbital motion of this component with respect to the center of gravity. In order to apply Kepler's third law, in each pair we must know the radius of the orbit of one component with respect to the other.

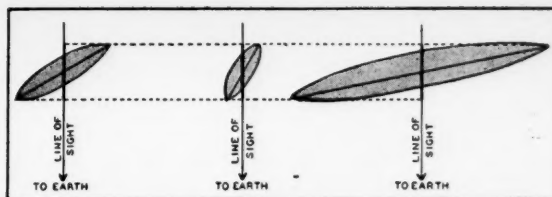
Moreover, these two pairs are not eclipsing variables, and the real inclinations of their orbits to the plane of the sky is unknown. If the inclination is not 90° (in the line of sight), the Doppler shift yields only the component of motion in the line of sight, so that the real orbital velocity in each case may be considerably larger than the observed one.

Finally, one of these pairs has an unsymmetrical orbit, the eccentricity of Castor A being 0.5, according to Miss Julie Vinter-Hansen, who in 1940 derived accurate sets of orbital elements for both pairs.

Fortunately, these difficulties can be partially overcome by a procedure that follows, in principle at least, the one we have described in the case of Castor C.

The observed velocity (real motion projected in the line of sight) of the brighter component of Castor B is 32 kilometers per second; that of Castor A's brighter component is nine kilometers per second. If each pair consisted

The problem of the inclination for spectroscopic binaries is illustrated here. These three schematic orbits have very different sizes, but their projections on the line of sight are the same.



of identical stars, then the observed motion of each component with respect to the other would be 64 and 18 kilometers per second, respectively, in circular orbits. But since we do not observe the spectral lines of the secondaries, we are certain that such an assumption would be incorrect. When only one spectrum of a binary is visible, the brighter star is usually at least twice as bright as the fainter, and therefore also more massive. To avoid this difficulty we must attempt to resolve the uncertainty of the orbital inclinations.

Are the inclinations of Castor A and B at all similar to the 90° of Castor C? If they were, we should have a strong argument in favor of the idea that the orbits are roughly coplanar, as are those of the planets in the solar system, and this would have a bearing upon the theory of the origin of multiple stars.

Although only a fraction of the 380-year orbit of α_1 around α_2 has been covered by visual micrometer observations, the inclination of the visual orbit is well known: 116° to the plane of the sky. Suppose we were to assume that the orbital inclinations of the two blue pairs are also 116° . We could then correct the orbital velocities for the effect of foreshortening, which would give 44 kilometers per second for Castor B (instead of 32) and 12 kilometers per second for Castor A (instead of nine).

This leads us directly to the problem of the masses, for according to Kepler's third law the orbital velocity of the more massive component of each pair is larger the greater the total mass, and is smaller the greater the ratio of this heavier mass to its companion's mass. It is easy to see that this is correct: The orbital velocity of the earth around the center of gravity of the earth-moon system is small, because the earth greatly exceeds the mass of the moon. At the same time, the orbital velocity of the earth

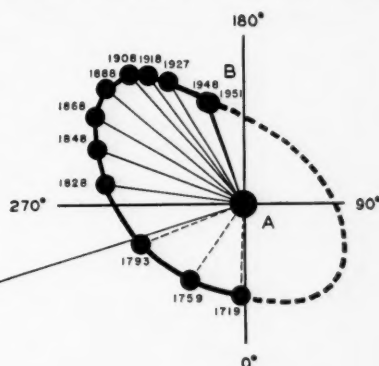
around the sun is larger than the velocity of the moon around the earth because the total mass, sun plus earth plus moon, is much larger than the mass earth plus moon.

Is our assumption of inclinations of 116° consistent with any reasonable distribution of the masses within each pair of the Castor system? Strangely, however, if such a reasonable distribution can be found, our problem remains unsolved, for we still would have no direct observation of the mass ratios. But if we should find the resulting mass ratios inherently improbable, then at least tentatively we could conclude that the assumption about the inclinations is incorrect and that the orbits are not, in fact, coplanar with the 380-year orbit of the bright stars.

The combined mass of the four stars constituting systems A and B was derived by W. J. Luyten, again from an application of Kepler's third law. The distance to Castor had to be known, but the ordinary methods of parallax determination, trigonometric and spectroscopic, are not accurate enough for this purpose. Hence, Luyten made use of the difference in the radial velocities of the centers of mass of Castor A and B. Combining this information with the orbital elements, he found the star's parallax to be 0.070 second of arc, corresponding to a distance of 47 light-years. The combined mass was then computed as six times the mass of the sun.

What about the individual masses? Most visual double star observers meas-

Castor		Visual Mag.	Period days	Mass (sun)	Type of Binary
A	α_2 Gem	2.0	9.2	3.2	Spectroscopic
B	α_1 Gem	2.8	2.9	2.3	Spectroscopic
C	YY Gem	9.7	0.81	1.4	Eclipsing



A diagram of the sextuple system of Alpha Geminorum. Castor A and B revolve around each other in 380 years; since 1719 about three fifths of the orbit has been completed. They are about 75 astronomical units apart, whereas Castor C is distant from them at least 1,000 astronomical units. All three stars are double.

ure the distance and position angle of the fainter object with respect to the primary. This procedure gives the greatest precision, but at the same time does not permit the computer to determine the mass ratio. However, catalogues of accurate star positions contain the individual motions of Castor A and B with respect to the distant, background stars. These proper motions yield the mass ratio. In the simplest case of a circular orbit, if the proper motions oscillate around the center of mass (which moves in a straight line) with equal amplitudes, the masses of the components are the same. If P oscillates half as much as S , then the mass of P would be twice that of S . In the case of Castor, the oscillations are not quite equal, Rabe finding Castor A to have 3.2 times the sun's mass, while Castor B has 2.3.

These are, in each case, the combined masses of a spectroscopic binary. We can now again make use of Kepler's third law and see whether we can adjust the mass ratios within each pair in such a way that the observed orbital motions would be 44 and 12 kilometers per second, respectively. The computation is a simple one, and it gives for A individual masses of 3.0 and 0.2 suns, while for B the masses are approximately 2.0 and 0.4 suns. The corresponding mass ratios are thus 15 and 5, respectively, which fits with the fact that the orbital velocities (projected or real) differ by a factor of more than three.

It is thus possible in a formal way to satisfy the condition of coplanar orbits in the A-B system, with a uniform inclination of 116° . But the resulting values of the masses of the lighter stars are inherently improbable. Indeed, we have on record very few stars whose masses are of the order of 0.2 times the sun's.

THE PROBLEM OF ORIGINS

Although we cannot prove our contention, it seems much more probable that the inclinations of both spectroscopic orbits, and especially that of Castor A, are much closer to 0° (or 180°). If the latter orbit were inclined some 30° to the plane of the sky, instead of 26° to the line of sight, the masses of the two components would be more reasonable.

Nevertheless, this discussion does not justify the assumption that the orbits are distributed *completely* at random. There may still be a slight tendency to conform to some preferential plane, with the directions of motion all in one sense. It would be of interest to study the rotational velocities of the bright blue stars. The absorption lines of the brighter component of A appear somewhat more washed out than do the lines of the brighter component of B. This washed-out appearance is caused by axial

rotation. We therefore conclude that the line-of-sight component of the equatorial rotation of the binary with the 2.9-day period is smaller than that of the 9.2-day binary. It is not possible, however, to determine from this observation whether or not the equatorial planes of the stars coincide with their orbital planes.

Our tentative conclusion that the orbital planes in Castor differ by large amounts finds strong support in a recent statistical investigation of triple systems by P. V. Grigorieff at Moscow. The distribution of the orbital planes in such systems must be reflected in the observed distribution of their differences in position angle. Grigorieff finds that the latter exhibits no departure from uniformity; hence, he believes that there is almost no relation between the planes of close pairs and those of their distant companions.

This does not of itself answer the difficult question of the origin of multiple stars, but it would strongly militate against the old fission theory, because the plane of rotation of an original single star would be preserved in subsequent fission processes. But it is also incompatible with the neo-Kantian theory which relates the origin of binaries to the condensation of turbulent cells within a highly flattened and rotating "solar nebula."

The 116° inclination of the visual A-B orbit differs by some 26° from the plane of YY Geminorum. These two

planes are thus not coincident, although the difference is perhaps not large enough to rule out an origin similar to that of the planets. The new theory of G. J. Odgers and R. Stewart, presented at the Victoria meeting of the American Astronomical Society this past June, may provide for a large dispersion in the inclinations by assuming that the turbulent motions in the original nebula were not confined to a preferential plane.

The system of Castor consists, as we have seen, of three narrow pairs whose separations are all quite similar, about $2/100$ of an astronomical unit. The separation of the two blue pairs, A and B, is of the order of 75 astronomical units—about twice the extent of our known system of planets. Castor C is at least 1,000 astronomical units removed from the center of gravity of A and B. This falls somewhere in between the outer cloud of comets in the solar system and the orbits of the planets.

It is difficult to visualize a process of condensation so far from the center of an original "solar nebula" formed around the two massive blue pairs of Castor. But independent formation of several stellar nuclei within a large, irregular cloud might account for the characteristics of this sextuple system. Perhaps we must eventually go back to the old hypothesis that regards the multiple stars as the remnants of a primordial star cluster.

TERMINOLOGY TALKS—J. HUGH PRUETT

Asteroids, Planetoids, Minor Planets

These terms describe the thousands of small bodies that revolve around the sun at distances mostly between the orbits of Mars and Jupiter. The gap between these planets is so large that in the year 1800 a group of 24 astronomers was formed to institute an organized search for a planet at a distance of 2.8 astronomical units from the sun, as required by Bode's law.

It is said that Giuseppe Piazzi, of Palermo, Sicily, was one of the selected 24, but he had not yet been informed of his part in the intended search. He was at the time surveying the heavens diligently with his telescope in his work of constructing an accurate star catalogue.

On the night of January 1, 1801, Piazzi recorded certain star positions. Checking over his work the next night, he noted that one of the stars on his map had moved somewhat during about 24 hours. He watched this "tailless comet" for about $1\frac{1}{2}$ months, but lost it when he became suddenly ill. From his records, however, Gauss was able to calculate an orbit, and announced the

body was at almost the mean distance of the missing planet of Bode's law. The new planet was lost for some time in the sun's rays, but on December 31, 1801, it was again located by von Zach. It was named Ceres, in honor of the tutelary divinity of Sicily.

In 1802, Pallas was found, and later Juno and Vesta. It was 1845 before the next of thousands of these minor planets was found. Since 1847, not a year has passed without one or more asteroid discoveries.

EDITOR'S NOTE:

With this issue, Terminology Talks concludes its appearance in *Sky and Telescope*. Its author, long associated with the general extension division of the University of Oregon, has been very generous not only in giving his time to preparation of material but in replying to numerous letters from readers. Terminology Talks has appeared monthly since August, 1947, and during this time Dr. Pruett has covered a wide range of topics in an interesting and informal style.

On behalf of our readers, we wish to express our deep appreciation for this service to the general cause of education in astronomy.

C. A. F.

Amateur Astronomers

AMATEUR ASTRONOMERS ASSOCIATION

At the opening meeting of its 26th season on October 1st, the Amateur Astronomers Association, New York City, is making three presentations of its Amateur Astronomers medal. The first is to Albert G. Ingalls, who conducts an amateur science department in *Scientific American*, for his advancement of amateur telescope making and his encouragement of military optical work by amateurs during the recent war.

Edward A. Halbach, Milwaukee Astronomical Society, is being honored for his leadership in that society's observational work and in eclipse programs. The third award is to David W. Rosebrugh, former president of the American Association of Variable Star Observers, for his decades of work on variables and for his numerous articles on all phases of amateur observing.

The Amateur Astronomers medal, established in 1943, has been previously awarded to Russell W. Porter, in 1948, and to Leslie C. Peltier, in 1950.

The series of classes presented annually by the Amateur Astronomers Association will get under way on October 6, 1952, with five courses scheduled, plus the telescope mirror making classes in the AAA's optical division workshop in the Hayden Planetarium.

A new course in Star Identification is being presented this year, with Pat Rizzo

as chairman, meeting on Wednesday evenings. Elementary Astronomy is on Mondays, with W. Wallace Benjamin as instructor. Intermediate Astronomy meets Tuesday evenings with Samuel C. Silver. A seminar on Recent Advances in Astronomy, Mary W. Schiffman, chairman, is scheduled for Thursdays. The association's Home Study Course, with Aileen A. Pindar as counselor, is being conducted again this year.

Further information about these classes and other activities of the society may be requested from the secretary, George V. Plachy, Amateur Astronomers Association, Hayden Planetarium, New York 24, N. Y.

THIS MONTH'S MEETINGS

Buffalo, N. Y.: Buffalo Astronomical Association, 8 p.m., Buffalo Museum of Science. Oct. 1, Benjamin Kolker, "Observing Conditions in and around Buffalo." Oct. 15, telescope clinic and observing.

Cambridge, Mass.: Bond Astronomical Club, 8 p.m., Harvard Observatory. October 2, Dr. Elisabeth Deichmann, Museum of Comparative Zoology, "Carl V. Solver's *Imago Mundi*, a Navigator's View on the Great Explorations."

Cleveland, Ohio: Cleveland Astronomical Society, 8 p.m., Warner and Swasey Observatory. Oct. 17, Dr. A. B. Meinel, Yerkes Observatory, "The Aurora Borealis."

Dallas, Tex.: Texas Astronomical Society, 8 p.m., Dallas Power and Light Co. auditorium. Oct. 27, E. M. Brewer, "Constellations."

Ft. Worth, Tex.: Ft. Worth Astronomi-

cal Society, 8 p.m., 3223 Westcliff Rd. West. Oct. 23, W. A. Mount, "Jupiter."

Indianapolis, Ind.: Indiana Astronomical Society, 2:30 p.m., Riley Library. October 5, Dr. James Cuffey, Indiana University, "Jupiter."

Miami Springs, Fla.: Gulfstream Astronomical Association, 8 p.m., intra-mural armory, University of Miami. October 24, annual meeting. Dr. Russell A. Williams, subject to be announced.

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. October 1, second Clyde Fisher memorial lecture, Dr. Charles H. Smiley, Ladd Observatory, "The Curvature of Space." Presentation of Amateur Astronomers medals by Te Ata, Mrs. Clyde Fisher.

Pittsburgh, Pa.: Amateur Astronomers Association, 8:15 p.m., Buhl Planetarium. Oct. 10, Z. Daniel, Allegheny Observatory, speaker.

South Bend, Ind.: St. Joseph Valley Astronomers, 8 p.m., Hotel LaSalle. Oct. 6, Mrs. Harriet B. Harmon, "The Big and Little Dippers"; William B. Williams, "Uranus."

Washington, D. C.: National Capital Astronomers, 8:15 p.m., Dept. of Commerce auditorium. Dr. E. P. Henderson, Smithsonian Institution, "What Do These Facts about Meteorites Mean, Mr. Astronomer?"

THE INDEX TO VOLUME XI

of Sky and Telescope is included in this issue. It may be removed from the staples in the center of the magazine, for binding at the front or back of the complete volume.

Planetarium Notes

BALTIMORE: Davis Planetarium. Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: 4 p.m. Monday, Wednesday, and Friday; Thursday evening, 7:45, 8:30, 9:30 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BOSTON: Little Planetarium. Boston Museum of Science, Science Park, Boston 14, Mass. Richmond 2-1410.

SCHEDULE: Tuesday through Friday, 3 and 4 p.m.; Saturday, 11 a.m., 2, 3, and 4 p.m.; Sunday, 2, 3, and 4 p.m. Spitz projector. Acting director, John Patterson.

BUFFALO: Buffalo Museum of Science Planetarium. Humboldt Parkway, Buffalo, N. Y., GR-4100.

SCHEDULE: Sundays, 2:00 to 5:30 p.m. Admission free. Spitz projector. For special lectures address Elsworth Jaeger, director of education.

CHAPEL HILL: Morehead Planetarium. University of North Carolina, Chapel Hill, N.C.

SCHEDULE: Daily at 8:30 p.m.; Saturday and Sunday at 3:00 p.m. Zeiss projector. Manager, A. F. Jenzano.

CHARLESTON, W. VA.: Hillis Townsend Planetarium. Public Library Building, Charleston, W. Va.

SCHEDULE: Saturday, 11:15 a.m. Special

showings on request. Admission free. Spitz projector. Director, Louise L. Morlang.

CHICAGO: Adler Planetarium. 900 E. Adams Bond Drive, Chicago 5, Ill., Wabash 1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Sundays, 2:30 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

KANSAS CITY: Kansas City Museum Planetarium. 3218 Gladstone Blvd., Kansas City 1, Mo., Chestnut 2215.

SCHEDULE: Saturday, 3:30 p.m.; Sunday, 3:00 and 5:00 p.m. Spitz projector. Director, Charles G. Wilder.

LOS ANGELES: Griffith Observatory and Planetarium. Griffith Park, P. O. Box 9787, Los Feliz Station, Los Angeles 27, Calif., Olympia 1191.

SCHEDULE: Wednesday and Thursday at 8:30 p.m.; Friday, Saturday, and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

NASHVILLE: Sudekum Planetarium. Children's Museum, 724 2nd Ave. S., Nashville 10, Tenn., 42-1853.

SCHEDULE: Sunday, 2:45, 3:30, 4:15. Spitz projector. Director, William G. Hassler.

NEW YORK CITY: Hayden Planetarium. 81st St. and Central Park West, New York 24, N. Y., Trafalgar 3-1300.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 2, 3, 4, 5, and 8:30 p.m.; Wednesdays and Fridays, 11 a.m., for school groups. Zeiss projector. Chairman, Robert R. Coles.

PHILADELPHIA: Fels Planetarium. Franklin Institute, 20th St. at Benjamin Franklin Parkway, Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesdays through Sundays, 3 p.m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: Buhl Planetarium and Institute of Popular Science. Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 3:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

PORTLAND, ORE.: Oregon Museum of Science and Industry Planetarium. 908 N.E. Hassalo St., Portland 12, Ore., East 3807.

SCHEDULE: Saturday, Sunday, and Wednesday, 4:00 p.m.; Tuesday, Thursday, and Friday, 8:00 p.m.; Saturday show for children only, 10:30 a.m. Spitz projector. Director, Stanley H. Shirk.

SPRINGFIELD, MASS.: Seymour Planetarium. Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, Frank D. Korkosz.

STAMFORD: Stamford Museum Planetarium. Courtland Park, Stamford, Conn.

SCHEDULE: Sunday, 4:00 p.m. Special showings on request. Admission free. Spitz projector. Director, Ernest T. Luhde.

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BOOKS AND THE SKY

THE ASTRONOMICAL UNIVERSE

Wasley S. Krogdahl. The Macmillan Company, New York, 1952. 599 pages and maps. \$6.25.

IF the line joining the sun and a certain planet sweeps over 8 per cent of the orbital area in 16 months, what is the planet's mean distance from the sun?

What causes the sun and moon to appear flattened near the horizon? Will they look more flattened to a fish than to a fisherman in a boat nearby?

What is the period of rotation of the tidal bulges? (Hint: One bulge is, ideally, directly under the moon.) How does this fact affect the rotation of the earth as a whole? How is such an effect detectable?

What is the absolute temperature of a perfect radiator whose rate of radiation is 46.332×10^{12} ergs per square centimeter per second?

In what ways does the motion of the high velocity stars set them apart? Do they differ in other respects?

Draw a schematic line profile of a rotating Be star. Account for each of its principal features. Do the same for the line profile of a P Cygni star.

How does one estimate the minimum age of the sun? Meteorites? The galaxy? The universe?

Here are a number of selected questions which appear in the newest college textbook in introductory astronomy. From the above questions (average: about 30 questions per chapter), the reader must be aware of the high quality of the material presented. The questions mirror the text's thoroughgoing analysis of classical and modern astronomy, as well as indicating here and there humorous and entertaining touches by the author. At times, the student will be compelled to strain his cogitative processes in seeking answers. However, when not in the body of the text, hints and pertinent data are suggested with the questions.

The *Astronomical Universe* is a textbook intended to satisfy the physical science requirement or to fulfill elective credits that a growing number of colleges and universities expect of their liberal arts students. Like all other writers in this field, Dr. Krogdahl has had to face the problem of presenting, largely to a freshman audience, material for which a considerable amount of mathematics and classical and modern physics is necessary for adequate understanding. This he has proposed to solve by reducing the application of mathematics to the lowest possible terms, for example, by employing a brightness scale and luminosities for the stars instead of the magnitude system (thus avoiding logarithms), and by schematizing the drawings and graphs to a high degree.

The consciously low emphasis on mathematics is explained by the author as due to the fact that "even the simplest mathematics seems to be a psychological incubus to all but students in the physical sciences proper." Most college teachers will wholeheartedly agree with this statement, but these incubi are not indigenous to mathematics alone.

On the other hand, no effort is spared

in preparing the groundwork for all the physics that is required. This material is presented only where and when needed. With this background the student is taken to the very forefront of astronomy, covering such diverse fields as peculiar stars, abundances of elements in the sun from a study of absorption lines, radio astronomy, modern cosmogonies, kinematical relativity, and so forth.

Much of this material, which general students in liberal arts may find difficult, is included with the basic idea that their interests and needs "are not hostile to or necessarily divergent from those of the very few students whose principal interest is astronomy." This dual purpose is responsible for the inclusion of the advanced topics. It should be emphasized, however, that each subject treated indicates careful prethought as to presentation and pedagogy. The explanations are full and show a lively imagination untainted by cliché analogies. Moreover, the written style flows in a general easygoing manner so the reader soon becomes engrossed.

Many readers will find delightful the quotations at the beginning of each chapter or major subsection. These run the gamut from poets like Noyes, to scientists like Lord Rayleigh, to children's favorites like Lewis Carroll. Thus in the chapter entitled "How Do We Know?" above the subsection describing how physical data concerning the stars are determined from binaries, we find,

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By Leo Mattersdorf

President, Amateur Astronomers
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This book describes in clear terms, for the average person to understand, the solar system, the stars, sun, moon, planets, eclipses, tides, how time is determined, and many other phases of astronomy. It is at once an introduction to astronomy and a basic discourse that will be helpful to young and old alike who thirst for elemental knowledge of the great mysteries of the universe.

It is illustrated with diagrams and photographs, and contains a suggested reading list.

223 pages \$3.50

Published by Lantern Press, Inc.,
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Harvard College Observatory
Cambridge 38, Mass.

"But you don't get honey with balloons!"

"I do," said Pooh. (A. A. Milne)

The chapter on "The Peculiar Stars" is preceded by,

"Interesting if true, and interesting anyway." (Mark Twain)

Before the section on indirect methods of analyzing the galaxy we find:

"So thass th' approach!" (Al Capp)

The photographic reproductions are all superior, with only one exception: On page 323 the photograph which is to demonstrate the proper motion of 61 Cygni does not show up the comparison stars nor 61 Cygni clearly enough. The diagrams and graphs are also of a uniformly high quality. One feature of many

of the graphs that is novel and may prove to be a little confusing at first is the custom of surrounding the graphed curves by a co-ordinate lattice. The H-R diagram consists entirely of such co-ordinate reticulation. With curves the advantage is that the student can estimate abscissae and ordinates with great ease.

Other features are an appendix containing constellation maps, a description of the magnitude system, a discussion of telescopes and observatories, and a bibliography. The index is very complete, containing with each page number a letter symbol indicating on what quarter of a page the subject is to be found, or whether it is to be found in a figure.

It is believed that this excellent book may prove more than a match for the average liberal arts student taking a course merely to fulfill a physical science requirement, as to both profusion and abstraction of material. For a somewhat maturer student — one who has had college physics of either the descriptive or more technical variety, or has had the equivalent of **An Introduction to Astronomy** by Baker, **The Astronomical Universe** is an exciting and thorough text.

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NEW BOOKS RECEIVED

FROM ATOMS TO STARS, *Martin Davidson*, 3rd edition, 1952, *Macmillan*. 280 pages. \$3.75.
The *Macmillan Company* is handling the American importation of this book, which was noted in *New Books Received* for April, 1952.

ACROSS THE SPACE FRONTIER, *Cornelius Ryan*, editor, 1952, *Viking*. 147 pages. \$3.95.

This "preview of what the conquest of space will mean to mankind" is a considerably expanded version of the *Collier's* magazine series, with chapters contributed by six authors. The book is illustrated by diagrams and many full-color pictures.

REDUCED OBSERVATIONS OF LUNAR OCCULTATIONS FOR THE YEARS 1943 TO 1947, *H.M. Nautical Almanac Office*, 1952, *H.M. Stationery Office*, London. 55 pages. No price given.

Compiled and discussed by Flora M. McBain, this material has been issued as an appendix to *Greenwich Observations 1939*. It is the first of the combined lists of all reduced occultations. Its publication "is an important step in the whole program for the encouragement of more observations of occultations." Reductions are now being done centrally in *H.M. Nautical Almanac Office* with the aid of punched-card machines; this will insure that the reductions are accurate, and will facilitate the application of limb correction as soon as C. B. Watts' work on the marginal zones of the moon is complete (*Sky and Telescope*, April, 1950, page 134). The next list will cover 1948-50, and it is expected that succeeding compilations will appear annually, about 18 months after the end of the year concerned.

The three principal lists in the publication give data on the observing stations, grouped by country; details of the individual observations, instruments, and methods; the results of the reductions.

LITTLE SHIP ASTRO-NAVIGATION, *M. J. Rantzen*, 1952, *Philosophical Library*. 160 pages. \$4.75.

This handbook for small craft owners who want to learn celestial navigation is based on the use of H.O. 214. There are examples and problems with answers; the necessary tables are reproduced in the appendix. The author is a lieutenant commander in the British naval reserve.



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GLEANINGS FOR ATM's

EDITED BY EARLE B. BROWN

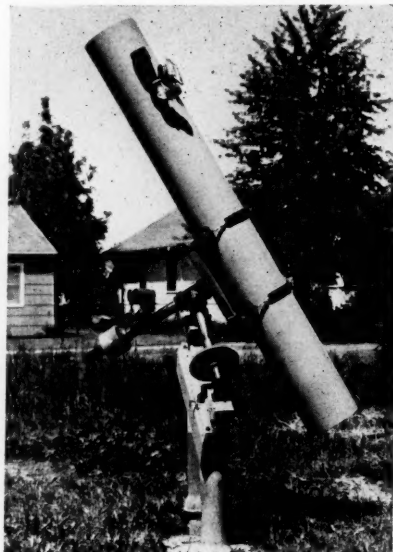
TURNING A WOODEN TELESCOPE TUBE

IF PORTABILITY is not a major concern, wooden telescope tubes are ideal, because this material substantially reduces thermal effects found in metal tubes, and improves seeing. As most reflector owners know, for convenience the tube should be rotatable so the eyepiece can be brought to a comfortable viewing position. This is difficult with tubes that are not round, for either a slip ring must be attached or the tube lifted and repositioned when it is necessary to change its observing orientation.

The apparatus described here is an improvised woodturning lathe for rounding my 16-sided 8' telescope tube. This tube is made of 16 1 x 3's with the edges sawed and planed to the proper angle for the best fit when formed into a tube. (One might use 17 slats for a roomier tube.) Well-seasoned lumber, vertical grained and free from pitch, will be necessary for best results. Cut three plywood disks to fit the inside of the tube and form the tube around them. Be sure the disks are only slightly smaller than the inside diameter of the tube; if they are too small, the tube will not be exactly round. Fasten a heavy tape around each end of the tube so you can grasp the ends of the tape to expand the tube for gluing.

Open up the tube over a convex surface so that the cracks between slats will be easy to reach with a brush. When the glue is spread, wrap the tube again around the plywood disks and force the joints together by tightening with metal straps or heavy rubber bands. When the glue is dry, the excess may be chipped off and the corners planed down to make the tube have 32 "sides."

Then set it up in the lathe as shown in the diagram. The project is not out of reach for anyone with a motor and a back yard. A is a stake set deep in the ground to make it very stable with the aid of the bracing shown. Perhaps the end of a shed or a tree would be even more suitable. B, large ball bearings; C, clamp or clamps to hold block containing the bearing; D, snug-fit plywood disk with 3" center hole;

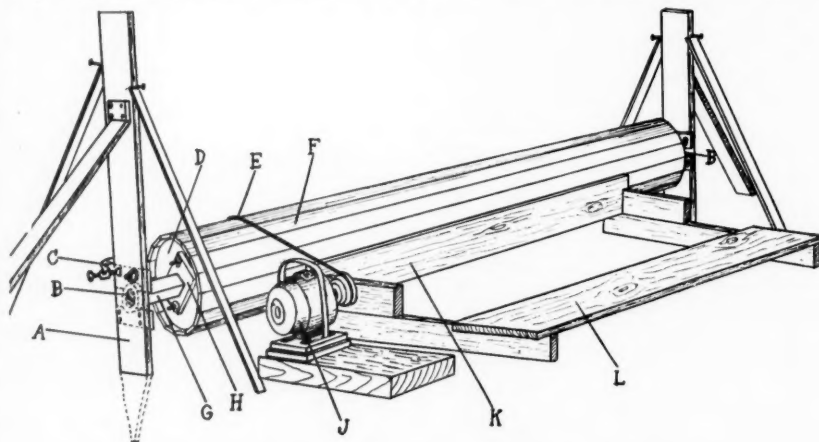


The George Andrus reflector, which has a wooden tube.

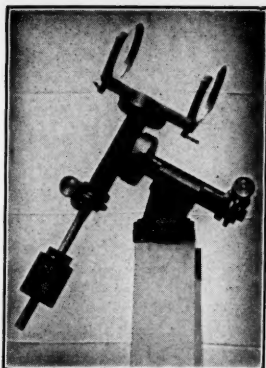
E, belt made of clothesline rope; F, 12" tube, 8' in length; G, 9' wooden shaft; H, block driven on shaft and adjustable on D to balance tube; J, motor, $\frac{1}{4}$ h.p. or larger; K, tool rest; L, seat for worker.

For turning, I used a wood chisel, plane, and emery paper. As the tube rotated at 500 r.p.m., a safety feature would be wire hoops around the tube in case it might fly apart. For painting one should leave the tube in the lathe, so that the desired number of coats may be sanded easily.

The nearly finished telescope shown in the accompanying photograph is mounted on a German-type equatorial, supported by two legs of 6" concrete pipe cast into a concrete block to support the axes and set in a half ton of concrete. The tube with the mirror can be carried by one person. The guide scope is made from one side of a three-inch binocular. For pho-



The lathe designed by George Andrus for making a wooden tube.



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tography a camera attachment is threaded into a brass plate cast to the curvature of the tube.

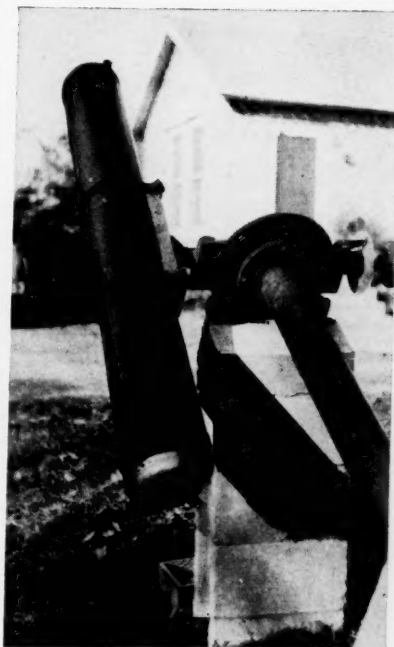
Were I to make another wooden tube this size or smaller, it too would be done on a lathe, because of the saving in labor and the smooth job it produces. Questions or exchange of ideas will be very welcome.

GEORGE ANDRUS

855 S. Chicago St.
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A HOME-MADE TELESCOPE

THE POLAR AXIS of my 6-inch reflector, pictured here, was made from part of an air stand from a filling station, a flywheel, a short piece of channel iron, and steel shafting. The bearings for the shafting came from a mill supply house. The shoulder on the flywheel is supported by two ball bearings. The bottom end of the axis was bored out and fitted with



The Pendergraft reflector is mounted on a pier of cement blocks. Like the Andrus instrument, this telescope has a wooden tube.

a short pin anchored in the concrete base just visible in the lower part of the picture.

The tube was made from a round wood column; this was taken apart and reduced in size, the pieces being put back together with glue and nails and smoothed up on the outside. The cell is made out of the heavy bottom part of a cooking pot from the kitchen. The focal length is 63 inches.

The axis is not exactly true north, but close enough to follow stars for about 1 1/2 hours; it was set up by estimation of latitude and north star direction from stakes driven in the ground at night from plumb-bob locations.

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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

SOUTHERN GLIMPSES FROM NORTHERN CLIMES

A GLANCE through the table of contents of the justly famous **Bedford Catalogue** of Admiral Smyth, that pioneer guidebook to the heavens for amateur astronomers, reveals that the southernmost celestial object listed therein is the 1st-magnitude star, Fomalhaut (α Piscis Austrini). Of course, the admiral was influenced by the latitude of his observatory in the British Isles when he fixed the southern limit to his **Cycle of Celestial Objects**.

On the other hand, many American authors of subsequent handbooks have chosen the more southerly situation of New York City (roughly 40° north) as the latitude of reference for their charts and descriptions. But, whether it was due to the influence of what Smyth included and excluded, or whether there was a natural reluctance to discuss a constellation which is not completely above the horizon for long in the designated latitude, many points of interest visible in the southern portion of the New York sky have been sorely neglected by these guides. As a result, many amateurs in the United States may be failing to give sufficient attention to these southerly objects.

A stargazer observing from New York notices that Fomalhaut is quite high in the heavens when it crosses the meridian. There is plenty of sky below it, although

it must be admitted that there was not that much for Smyth.

This neglect of southerly objects by some writers is not completely consistent. When describing Scorpius, for instance, for the latitude of New York, they usually include the whole constellation, whose lower limit is quite a bit below Fomalhaut's height in the sky. It is a familiar sight to see the whole outline of the Scorpion stretched out in the heavens, and we are not necessarily observing to the level of the horizon. Perhaps, if our street is wide enough, we can remain on our porch, look over the roof of a low house across the way, and still see the complete Scorpion.

Without looking any lower in the sky, and gazing directly south, we can, if we bide our time, see practically all of Caelum, the Graving Tool; Columba, the Dove; Fornax, the Furnace; Sculptor, the Sculptor's Workshop—Antlia, the Pump; Pyxis, the Mariner's Compass; Puppis, the Stern—Piscis Austrinus, the Southern Fish; Microscopium, the Microscope; Corona Australis, the Southern Crown. In addition, we will observe half of Grus, the Crane; Centaurus, the Centaur; Lupus, the Wolf; a third of Vela, the Sails. By not observing clear to the southern horizon, we have also allowed for those observers living somewhat north of 40° .

This list excludes Cetus, Eridanus, Lepus, Hydra, and Sagittarius, because they have been usually adequately described.

As the outlines of these southern constellations are unfamiliar, if we use star charts such as those in Norton's **Star Atlas** or the Skalnate Pleso **Atlas**, it would be helpful, before observing, to draw lines connecting the principal stars; this will help fix the constellation figures in mind. In some cases it may be necessary to employ binoculars to help trace the patterns of the stars.

For naked-eye glimpses of these southern constellations, the following may be helpful. Columba is below Lepus, which lies directly west of Canis Major. Adjacent to Columba and west of it lies Caelum. Fornax is below eastern Cetus and part of Eridanus. Sculptor lies below the western part of Cetus, with Phoenix directly below Sculptor. Piscis Austrinus is below Aquarius, with Grus, in turn, farther south. Microscopium is south of Capricornus, and Corona Australis is under the teapot in Sagittarius. Lupus is south of Libra and precedes Scorpius across the meridian. Centaurus is found under the eastern part of Hydra. Puppis lies east and south of Canis Major, and Pyxis is directly east of Puppis, with Vela below Pyxis.

Telescopic wonders abound in these constellations and keep the amateur occupied. There need not be too great a fear of the poor seeing so near the horizon. A good part of the gemlike sparkling beauty of the stars in the galactic cluster M7 in the southern part of Scorpius, as seen in a small telescope, may be due to the denser

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atmosphere their light traverses. It is a pity the **Bedford Catalogue** as originally published did not extend far enough south to include this marvel; Smyth's description would have done it justice.

Classifying some of the things to be seen by constellation, during October evenings *Piscis Austrinus* is on the meridian. Both Beta and Gamma are double. To the south, *Grus* contains a cluster of faint galaxies, of which NGC 7599, 7590, and 7582 are 12th-magnitude members.

In *Sculptor*, Tau is a double star. Here we view the globular cluster NGC 288 (magnitude 9.0) and the galaxy NGC 253 (magnitude 7.0). For more galaxies, look for a cluster of them in *Fornax*. This constellation has double stars Omega and Alpha.

Puppis, visible in late winter evenings, embraces M46 and M93, galactic clusters, and the planetary nebula NGC 2440. It also contains galactic clusters NGC 2587, 2571, 2567, and 2580, near the boundary of *Pyxis*, as well as NGC 2422 west of M46. L_2 is a famous variable star. For double stars in the constellation, we might have a look at Pi and Sigma.

Gamma *Velorum* is double, and east of it we find the galactic cluster NGC 2659. Look also for the 9th-magnitude globular, NGC 3201, in the eastern part of the constellation. In *Pyxis* we find more galactic clusters, two examples of which are NGC 2627 and 2658.

For a galaxy, we can observe 11th-magnitude NGC 2997 in *Antlia* on April evenings. To the east, *Centaurus* covers a

large area and is favored with bright stars. The galaxy NGC 5128, of the 7th magnitude, is in this constellation.

Lupus is known for its two neat doubles, Xi and Eta, and the globular cluster NGC 5986 (magnitude 8.7). Gamma of *Corona Australis* is double. In this constellation we find the globular cluster NGC 6541, with the globular NGC 6723 lying in *Sagittarius* just above the boundary of the *Southern Crown*. Both of these are of the 8th magnitude.

The north circumpolar constellations are always with us. We can afford to postpone looking at them until a later time. But to catch glimpses of these southern constellations as they parade with the seasons across our southern meridian, let us start now.

P. V. RIZZO
1881 61st St.
Brooklyn 4, N. Y.

SUNSPOT NUMBERS

July 1, 47, 59; 2, 46, 55; 3, 37, 39; 4, 31, 31; 5, 21, 26; 6, 20, 12; 7, 18, 13; 8, 31, 19; 9, 44, 44; 10, 56, 52; 11, 59, 70; 12, 60, 66; 13, 69, 72; 14, 89, 93; 15, 139, 90; 16, 74, 85; 17, 47, 53; 18, 33, 43; 19, 28, 23; 20, 32, 30; 21, 19, 25; 22, 10, 9; 23, 11, 9; 24, 10, 9; 25, 19, 17; 26, 13, 11; 27, 23, 19; 28, 25, 23; 29, 27, 26; 30, 33, 36; 31, 52, 60. Means for July: 39.4 American; 39.3 Zurich.

Daily values of the observed mean relative sunspot numbers for April are given above. The first are the American numbers computed by Neal J. Heines from Solar Division observations; the second are the Zurich Observatory numbers.

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SUNSHINE FIREBALL

At approximately 10:30 a.m. MST, July 7, 1952, numerous residents of the Pacific Northwest were startled by the appearance of a brilliant daytime meteor. The American Meteor Society's representative received 74 first-hand observers' accounts, from Washington, Idaho, Montana, Oregon, California, Nevada, Utah, and Wyoming. The meteor was seen from localities 500 miles from its spectacular flight.

The name "Sunshine Fireball" was given this unusual object by my Oregon assistant for the AMS, Phil F. Brogan, of the Bend Bulletin. Some said it was as bright as the sun; others, that it was as large as the full moon or somewhat smaller. Hardly anyone gave the duration of visibility as more than two or three seconds. No sounds were heard.

Four fine instrumental readings from widely separated localities determined the sub-end point quite accurately. An observer at Laurel, Mont., had a definite landmark for measuring the altitude of the disappearance, which was over 300 miles from him. Using his angle and distance, and allowing for the curvature of the earth, the disappearance height was 23 miles. Other observations run somewhat above and below this figure.

The ground path was very short, hardly over 100 miles, because the fireball came down at a very steep angle. Many persons reported the fall was vertical. The luminous part of the path started over the northwestern corner of Utah and ended about 55 miles east of Twin Falls, Idaho. The direction of flight was toward the west of north.

J. HUGH PRUETT

JULY VENUS OCCULTATION

Wilbur Stone and I observed the occultation this morning, July 22nd, with his 4-inch equatorial of 62 1/2-inch focal length and a 1 1/2-inch eyepiece for 41 power. Venus was picked up in the finder at 9:00 a.m. EST using the co-ordinates given in the July issue. By a stop watch and WWV time signals, the disappearance was timed at 9:33:37 a.m. EST. Our station was at 37° 34' 5" N., 77° 26' 13" W.

Fading of the image from first contact to total extinction was quite perceptible and lasted an estimated two seconds. At no time did we see any part of the moon. The sky was bright and clear but scattered clouds formed about 11 o'clock. Incidentally, the temperature under the dome was 102.

BEAUFORT S. RAGLAND
203 Exchange Bldg.
Richmond 19, Va.

In Rochester the immersion was timed at about 14:51 UT, without radio time signals. Observations were made with an 8-power telescope having a 2-inch f/4.5 objective. The planet was picked up directly without the aid of setting circles, making use of the approximate vertex angle and elongation from the sun as guides.

The actual immersion was observed through a built-in red filter, following the recommendations of Ralph Dakin of our club. The filter was effective, although it did not make so much difference as it

would at greater elongations where the sunlight is more predominantly blue. There was no sign of the moon all morning. This made it impossible to watch for the emersion without very accurate setting circles. The sky was clear with only a moderate haze.

I made no attempt to estimate the duration of dimming but feel sure it was longer than the two seconds reported by Mr. Ragland. Since the moon moves approximately its own diameter in an hour, and the planet's diameter was five seconds of arc, actual immersion occupied at least 10 seconds. At low powers that do not resolve the disk, the eye would not notice the dimming until the planet was about half covered and hence of about half the apparent brilliance. (An experienced variable star observer might note dimming sooner.) Accordingly, the useful working rule is that for a central occultation apparent dimming at immersion lasts in seconds of time about the planetary diameter in seconds of arc. This occultation was far from central, so dimming should have appeared to take even longer.

PAUL W. STEVENS
2322 Westfall Rd.
Rochester 18, N. Y.

OCCULTATIONS BY JUPITER

Harvard Announcement Card 1185, August 20, 1952, carries predictions of occultations of stars by the planet Jupiter, communicated by Prof. I. Yamamoto, Kyoto University Observatory.

On October 9th, Jupiter will pass in front of BD +15°447, a star of magnitude 7.3. The immersion should be visible "at the Pacific Coast of North America," and points west. The times given are 15:48 UT for Kyoto, Japan, and 15:53 for Hyderabad, India. Emersion will be seen only in the Eastern Hemisphere; at 19:13 at Bloemfontein, South Africa.

On November 20th, Sigma Arietis, of magnitude 5.5, will be hidden by Jupiter, immersion visible in the western part of North America, the Pacific Ocean, Australia, and eastern Asia. The predicted time is 10:51 UT at San Francisco, with the position angle about 210°. Emersion at San Francisco will be at 12:40 UT, position angle about 115°. The predicted times may be uncertain by as much as 10 minutes.

Observation of these phenomena is recommended both for position and for the study of Jupiter's atmosphere. The emersions are at the bright limb of the planet.

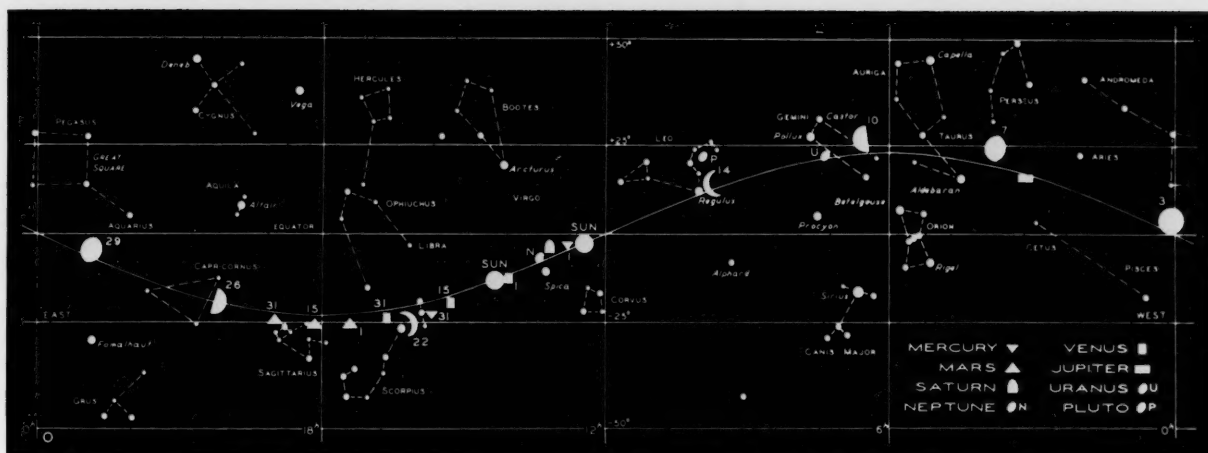
MOON PHASES AND DISTANCE

Full moon	October 3, 12:15
Last quarter	October 10, 19:33
New moon	October 18, 22:42
First quarter	October 26, 4:04
Full moon	November 1, 23:10

	October	Distance	Diameter
Perigee 1, 13 ^h	225,100 mi.	32' 59"	
Apogee 13, 10 ^h	251,500 mi.	29' 31"	
Perigee 29, 6 ^h	228,400 mi.	32' 30"	

November

Apogee 10, 6 ^h	251,200 mi.	29' 34"
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THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury will be poorly situated this month in the evening sky. Elongation occurs on November 10th, but at the end of October Mercury sets about 45 minutes after sunset, very far in the southwest. However, in the Southern Hemisphere this will be a fine apparition.

Venus emerges from the evening twilight late in October, setting 1½ hours after the sun. During the month, the brilliant planet moves from eastern Virgo through Libra and Scorpius into Ophiuchus. On the 29th, Venus will be about 3½° north of Antares. Telescopically, the disk of Venus appears a rather small 12" in diameter, 87% illuminated on the 15th.

Mars, in the southwestern sky after sunset, is of magnitude +0.7 on the 15th, continuing to fade as it nears the sun. The ruddy planet moves eastward through

Ophiuchus and Sagittarius this month.

Jupiter, shortly after sunset, rises in the east, unmistakable in its brilliance at magnitude -2.4 on the 15th. Opposition takes place on November 8th; hence the planet is in retrograde motion. The bright satellites with their ever-changing configurations can be viewed with small instruments. The disk of Jupiter has an equatorial diameter of 48" in mid-October.

Saturn passes conjunction with the sun on October 11th, reappearing in the morning sky late in the month.

Uranus comes to western quadrature on October 11th, located in Gemini about 1° northeast of Delta. Retrograde motion commences on the 24th, with Uranus rising about 11 p.m. local time.

Neptune enters the morning sky on October 14th, passing conjunction with the sun; hence it is invisible.

METEORS IN OCTOBER

The Orionids, one of the better annual meteor swarms, may favorably be observed without interference from the moon. Maximum rates occur on October 19-20, with a total duration of about 10 days. Under good conditions about 20 meteors per hour may be recorded after midnight. The radiant is around 10° northeast of Betelgeuse (6h 24m, +15°), with swift meteors characteristic of this shower.

Late in the month, the Taurid meteors commence, a diffuse shower with maximum occurring the first 10 days of November and predicted rates of six per hour.

E. O.

DEEP-SKY WONDERS

GLOBULAR CLUSTERS of special interest at this season include NGC 7078, M15, in Pegasus at 21h 27m.6, +11° 57'. Its diameter is 12.3, magnitude 7.3. Discovered by Maraldi in 1746, it is a noble cluster with stragglers branching from a central blaze.

Try next NGC 7089, M2, 21h 30m.9, -1° 3', 11.7, mag. 7.3, also found by Maraldi in 1746. John Herschel compared it to a heap of fine sand.

Farther south is NGC 7099, M30, 21h 37m.5, -23° 25', 8.9, mag. 8.6, discovered by Messier in 1764; it is situated in a "blankish space."

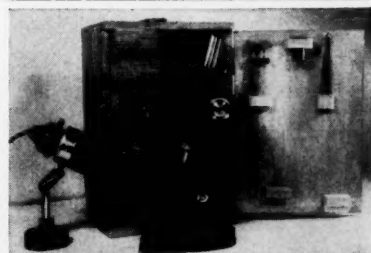
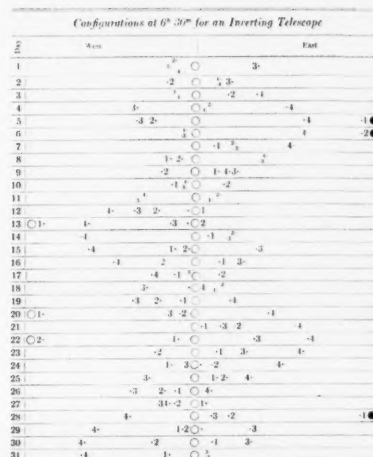
Much harder to locate is NGC 7492, 23h 5m.7, -15° 54', 4.3, mag. 12.3. First observed by William Herschel in 1786, this faint object is not usually listed on charts; it is perhaps a real feat to find with an amateur-sized instrument.

These globulars are the last four listed in Dr. Helen B. Sawyer's bibliography of individual globular clusters, published by the David Dunlap Observatory of the University of Toronto in 1947.

WALTER SCOTT HOUSTON

JUPITER'S SATELLITES

Jupiter's four bright moons have the positions shown below for the Universal time given. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the *American Ephemeris and Nautical Almanac*.



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NORTON'S "Star Atlas and Reference Handbook," latest edition 1950, \$5.25; "Bonner Durchmusterung," southern parts, \$38.50, northern parts in print; Elger's map of the moon, \$1.50; McCrea, "Physics of the Sun and Stars," \$2.00; Lovell and Clegg, "Radio Astronomy," \$3.65. All domestic and foreign publications. Herbert A. Luft, 42-10 82nd St., Elmhurst 73, N. Y.

OCCULTATIONS OF THE BEEHIVE AND THE PLEIADES

The moon will pass through the constellation of Cancer on the morning of October 12th, and while doing so will occult some of the faint stars that make up the famous Beehive cluster. Before dawn, observers at standard stations **A, C, E,** and **F** should be able to observe some emersions from the dark limb of the 23-day-old moon. Observers in Canada will find the moon too far south for more than grazing occultations in most cases.

These stars are faint, all below magnitude 6.0, and hence are not usually carried in our occultation predictions. But Paul W. Stevens, of Rochester, N. Y., has sent the following table of emersion predictions for Cambridge, Mass., where sunrise will be at 10:51 UT. The stars are listed by their catalogue numbers in the *American Ephemeris*.

Star	Magnitude	Emersion
1282 — 35 Cancr	6.6	7:04
1287 — 94 B Cancr	6.7	8:14
1294 — BD + 20° 2152	6.9	9:31
1293 — 98 B Cancr	6.7	9:32
1299 — Epsilon Cancr	6.3	9:38
1297 — BD + 19° 2069	6.8	10:16

To our regular occultation predictions here we have added the stars Epsilon and 102 B Cancr. Comparison of their emersions with predicted times for other stars in the Beehive above should permit rough estimates of their corresponding emersions at other stations.

Early in November, the full moon will make a passage across the Pleiades, occulting Taygeta (19 or q) and Maia (20), but missing the other bright stars of the cluster at the standard stations (except 16 at station I). These occultations will be visible on the morning of November 3rd at all standard stations except **F**, with immersion for Maia occurring at 10:31.7 at **C**, Washington, D. C. The moon's phase will make observations of these occultations difficult. In December, many of the Pleiades will be occulted by an 11-day-old moon.

PREDICTIONS OF BRIGHT ASTEROID POSITIONS

Isis, 42, 9.7. Oct. 5, 2:18.4 — 0:57; 15, 2:09.2 — 1:29; 25, 1:58.9 — 1:48. Nov. 4, 1:49.2 — 1:47; 14, 1:41.4 — 1:25; 24, 1:36.2 — 0:41.

Virginia, 50, 9.7. Oct. 5, 2:20.7 + 11:02; 15, 2:15.4 + 10:07; 25, 2:08.4 + 9:07. Nov. 4, 2:01.2 + 8:12; 14, 1:55.3 + 7:31; 24, 1:52.1 + 7:13.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1952.0) for ϕ^0 Universal time. In each case the motion of the asteroid is retrograde. Data supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

MINIMA OF ALGOL

October 1, 9:26; 4, 6:14; 7, 3:03; 9, 23:52; 12, 20:41; 15, 17:29; 18, 14:18; 21, 11:07; 24, 7:56; 27, 4:44; 30, 1:33. November 1, 22:22; 4, 19:11.

These predictions are geocentric (corrected for the equation of light), based on observations made in 1947. See *Sky and Telescope*, Vol. VII, page 260, August, 1948, for further explanation.

OCCULTATION PREDICTIONS

October 5-6 **Epsilon Arietis** m 4.6, 2:56.5 + 21:09.0, 17, Em: **E** 2:56.7 + 0.8 + 2.8 190; **G** 3:27.4 + 0.3 + 1.7 234.

October 11-12 **Epsilon Cancr** 6.3, 8:37.7 + 19:43.0, 23, Em: **A** 9:39.1 ... 359; **C** 9:46.6 — 1.5 — 2.4 335; **E** 9:23.4 — 1.4 — 2.7 342; **F** 9:25.4 — 1.1 — 0.3 305.

October 11-12 **102 B Cancr** 6.5, 8:37.7 + 19:50.4, 23, Em: **F** 9:04.3 — 1.5 — 2.6 340.

November 2-3 **q Tauri** 4.4, 3:42.3 + 24:19.1, 15, Im: **A** 9:56.9 — 0.6 — 1.5 97; **B** 9:52.1 — 0.8 — 1.3 88; **C** 10:00.4 — 0.6 — 2.1 113; **D** 9:49.8 — 0.9 — 1.6 98; **E** 9:45.1 — 1.2 — 2.6 120; **G** 8:56.0 — 1.5 + 0.3 77; **H** 8:56.5 ... 133; **I** 8:41.1 — 1.5 + 0.8 75. Em: **D** 10:54.7 — 0.7 — 0.7 250; **E** 10:43.7 — 1.4 + 0.6 225; **G** 10:12.8 — 1.4 — 0.3 255; **H** 9:39.2 ... 192; **I** 9:59.4 — 1.6 + 0.2 252.

November 2-3 **20 Tauri** 4.0, 3:43.0 + 24:13.2, 15, Im: **A** 10:19.9 — 0.2 — 2.5 123; **B** 10:12.6 — 0.4 — 2.2 114; **C** 10:31.7 + 0.4 — 4.6 148; **D** 10:14.8 — 0.4 — 2.9 127; **G** 9:18.0 — 1.7 — 1.2 107; **I** 9:02.9 — 1.9 — 0.7 107. Em: **G** 10:24.1 — 1.4 + 0.9 227; **I** 10:09.1 — 1.4 + 1.6 222.

For standard stations in the United States and Canada, for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, a and b quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The a and b quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. Lo, lat. L) within 200 or 300 miles of a standard station (long. LoS, lat. LS). Multiply a by the difference in longitude (Lo — LoS), and multiply b by the difference in latitude (L — LS), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A + 72° .5, + 42° .5	E + 91° .0, + 40° .0
B + 73° .6, + 45° .6	F + 98° .0, + 31° .0
C + 77° .1, + 38° .9	G + 114° .0, + 50° .9
D + 79° .4, + 43° .7	H + 120° .0, + 36° .0
I + 123° .1, + 49° .5	

VARIABLE STAR MAXIMA

October 2, **T Cassiopeiae**, 7.8, 001755; 5, **SS Virginis**, 6.9, 122001; 16, **R Leonis Minoris**, 7.2, 093934; 18, **R Ophiuchi**, 7.6, 170215; 24, **W Hydrae**, 7.0, 134327. November 1, **R Leporis**, 6.7, 045514; 2, **R Normae**, 7.2, 152849; 3, **RT Cygni**, 7.4, 194048; 4, **U Cygni**, 7.6, 201647.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the predicted magnitude, and the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern).

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, and the result is your standard time on the day preceding the Greenwich date shown.



STARS FOR OCTOBER

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time,

on the 7th and 23rd of October, respectively; also, at 7 p.m. and 6 p.m. on November 7th and 23rd. For other times, add or subtract ½ hour per week. When fac-

ing north, hold "North" at the bottom; turn the chart correspondingly for other directions. The projection (stereographic) shows celestial co-ordinates as circles.



